COSEWIC
Assessment and Status Report

on the

Caribou
Rangifer tarandus

Newfoundland population
Atlantic-Gaspésie population
Boreal population

in Canada

Newfoundland population - SPECIAL CONCERN
Atlantic-Gaspésie population - ENDANGERED
Boreal population - THREATENED
2014

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

COSEWIC. 2014. COSEWIC assessment and status report on the Caribou *Rangifer tarandus*, Newfoundland population, Atlantic-Gaspésie population and Boreal population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxiii + 128 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

Previous report(s):

COSEWIC. 2014. COSEWIC assessment and status report on the Caribou *Rangifer tarandus*, Northern Mountain population, Central Mountain population and Southern Mountain population in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxii + 113 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

Previous report(s):

COSEWIC. 2002. COSEWIC assessment and update status report on the woodland caribou *Rangifer tarandus caribou* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 98 pp.

Thomas, D.C., and D.R. Gray. 2002. Update COSEWIC status report on the woodland caribou *Rangifer tarandus caribou* in Canada, *in* COSEWIC assessment and update status report on the Woodland Caribou *Rangifer tarandus caribou* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-98 pp.

Kelsall, J.P. 1984. COSEWIC status report on the woodland caribou *Rangifer tarandus caribou* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 103 pp.

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur le Caribou (*Rangifer tarandus*), population de Terre-Neuve, population de la Gaspésie-Atlantique et population boréale, au Canada.

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Caribou — Top photo: Newfoundland Caribou - Photo credit: Mahoney, S. P. Centre photo: Gaspésie Caribou - Photo credit: Federal Recovery Plan. Bottom photo: Boreal Caribou - Photo credit: Gilles Duchesne.

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COSEWIC
Assessment Summary

Assessment Summary – November 2014

Common name
Caribou - Newfoundland population

Scientific name
Rangifer tarandus

Status
Special Concern

Reason for designation
This population was last assessed as Not at Risk in 2002 when the population was 85,000. This population has fluctuated in abundance over the last 100 years and presently has declined by approximately 60% over the last 3 caribou generations. The decline was due to limited forage when the population was at high density, harvest, and predation. Various indices suggest that the population is improving but there is concern that Eastern Coyote, which has recently arrived to Newfoundland, may become a significant predator and influence recruitment such that the population continues to decline.

Occurrence
Newfoundland and Labrador

Status history
Newfoundland population was designated Not at Risk in April 1984. Status re-examined and confirmed in May 2000 and in May 2002. Status re-examined and designated Special Concern in November 2014.

Assessment Summary – November 2014

Common name
Caribou - Atlantic-Gaspésie population

Scientific name
Rangifer tarandus

Status
Endangered

Reason for designation
This small isolated population has declined to fewer than 120 adults. Historically, these caribou were much more widely spread, occurring in New Brunswick, Nova Scotia, and Prince Edward Island. Today, they mainly use alpine habitats on mountain plateaus in the Gaspésie region, in Quebec. Habitat has been modified by resource development, including forest management that reduced forest age, and increased density of predators of caribou. Adult mortality and continued low calf recruitment due to Eastern Coyote and Black Bear predation are contributing to an ongoing decline. Population models predict the population may become extinct by 2056.

Occurrence
Quebec

Status history
Atlantic-Gaspésie population designated Threatened in April 1984. Status re-examined and designated Endangered in May 2000.Status re-examined and confirmed in May 2002 and November 2014.

Assessment Summary – November 2014

Common name
Caribou - Boreal population

Scientific name
Rangifer tarandus

Status
Threatened

Reason for designation
This population occurs at naturally low densities in mature boreal forest habitats from Labrador to Yukon, with small, isolated populations at the southern part of the range, including along the Lake Superior coastline and in the Charlevoix region of Québec. Over the past century, local subpopulations have been lost; range contraction has proceeded from the south by up to 50% of historical range in some areas. Despite considerable conservation efforts, range-wide declines have continued since the last assessment in 2002, particularly in Alberta, northeastern British Columbia, and Labrador. Some populations remain poorly monitored, particularly those in the northern portion of the range. For 37 of 51 subpopulations where trend data are available, 81% are in decline, as indicated by negative population growth rates. Some of the most intensively managed subpopulations may remain critically imperiled. Reasons for decline are mainly due to increased predation and habitat loss, the latter stemming from the combination of anthropogenic (natural resource extraction) and natural (fires) disturbance. The proliferation of linear landscape features such as roads and seismic lines facilitates predation by wolves, and the conversion of mature – old conifer stands to younger seral stages promotes increases in alternate prey such as Moose and White-tailed Deer. Shifts in the northern distribution of White-tailed Deer, mediated by landscape change, also bring novel parasites into parts of the range of this population. In some regions, overhunting poses a threat to long-term conservation. Threats are closely interrelated and act cumulatively to impact this population. Population increases do not appear likely in one-third of subpopulations where disturbances exceed a threshold of viability. A >30% decline in population is projected in the near term.

Occurrence
Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Newfoundland and Labrador

Status history
The Boreal population was designated Threatened in May 2000. This newly-defined population is comprised of a portion of the de-activated "Western population" and all of the de-activated "Labrador-Ungava population". Status re-examined and confirmed in May 2002 and November 2014.

COSEWIC
Executive Summary

Caribou
Rangifer tarandus

Newfoundland population
Atlantic-Gaspésie population
Boreal population

Wildlife Species Description and Significance

Caribou (*Rangifer tarandus*) are a medium-sized member of the deer family with relatively long legs and large hooves, which facilitate survival in northern environments. Caribou are central to the culture, spirituality, and subsistence lifestyles of many Aboriginal and non-Aboriginal communities across Canada. Caribou exhibit tremendous variability in morphology, ecology, and behaviour across their circumpolar range. In 2011, COSEWIC recognized 12 designatable units (DUs); this report assesses three DUs: Newfoundland population (NP; DU5); Atlantic-Gaspésie population (GP; DU11); and Boreal population (BP; DU6).

Distribution

In NP, about 14 sub-populations are presently recognized, and Caribou can still be found in most of their former range. The GP is the only Caribou population south of the St-Lawrence River. It is now found primarily in the McGerrigle/Chic-Chocs Mountains in the Gaspésie Peninsula, QC, and the majority live within Gaspésie National Park. The BP have been extirpated from about half of their historic range in Canada in the last 150 years. They presently occur from southern Labrador to eastern Yukon, generally south of the northern treeline of the boreal forest. Northward range recessions have been observed in most provinces and have led to isolation and fragmentation of sub-populations in some regions.

Habitat

NP Caribou use coniferous forests, barren lands, shrub lands, and wetland complexes. The GP uses alpine habitat on mountain plateaus > 700 m asl and mature Balsam Fir and spruce forests found on mountain slopes. The alpine habitats are important for the GP throughout the year. BP Caribou will use younger forest and hardwood stands if imbedded in coniferous forest, but primarily use mature or old stands of Black Spruce and Jack Pine, peatlands, bogs, and fens. Shorelines and islands in large lakes are used during calving to provide spatial separation from predators. Habitat avoidance for BP is primarily

based on minimizing predation risk, which can be associated with anthropogenic disturbance, and secondarily by forage availability. Selection of closed-canopy conifer forests by Caribou generally becomes stronger with increasing disturbance levels. Anthropogenic disturbance tends to lead to the functional loss of residual habitat.

Biology

Typical longevity in Caribou is < 10 years in males and < 15 years in females. Females ≥ 3 years old give birth to a single calf annually, resulting in an overall lower reproductive rate when compared to other North American deer species. Generation time is estimated at 6 years. Reproductive success is closely linked to forage availability.

Population Sizes and Trends

The NP has experienced dramatic fluctuations, at least since the early 1900s; after a peak estimate of 100,000 individuals in the 1900s, the population declined approximately 85% to 10,000-15,000 individuals between 1925 and 1935, then increased approximately 84% over four decades, and reached 94,000 individuals by the mid-1990s. By 2002, the NP declined to 68,000 individuals, and continued to decline, to approximately 32,000 in 2013. The three generation (18 year; 1996-2013) trend is – 62%. The decline is believed to be due to limited forage that reduced juvenile productivity and survival, excessive hunting during the decline phase and, possibly, additive predation. The present decline appears to be part of natural population fluctuations and recently several indices on health and calf survival suggest that the population will increase.

The population of the GP fluctuates but there has been a general decline in the number of mature animals since the 1950s. The GP was first estimated between 700 and 1,500 individuals (of all ages) in the 1950s. Improved survey methods began in 1983. From 1983-2013, the population declined from an estimated 274 (219 mature animals) in 1983 to 130 (112 mature) in 2013 (- 49% change in mature animals). Fluctuations occur due to natural factors and predator control, which increases juvenile survival. The highest population level in the last 30 years was 219 mature animals (1983) and lowest is 65 (2012). The three generation decline is 25%, but varies greatly depending on any 18-year period used.

Caribou in the BP are difficult to survey because they live in small groups within large areas under forest cover. Population estimates over time are unavailable in most regions. The 2002 COSEWIC assessment estimated 33,000 animals and the 2012 National Recovery Strategy estimated 34,000 animals (including calves). However, the values are very crude and detailed surveys and disturbance levels in separate ranges indicate declines in much of the southern 1/3 of the DU range and population. Fifty population ranges were assessed based on probability of persistence associated with anthropogenic and natural disturbance levels. Fourteen ranges (65% of the total DU range; or 59%, based on Ontario's reassessment) were considered to be 'self-sustaining' (*i.e.* viable). Thirty-five percent of DU area and 32% of the population are considered not, or possibly not, self-sustaining. Most (81%) of the 37 sub-populations with finite growth rate (Lambda) data

since 1996, which represents > 90% of DU range, are negative (mean Lambda = 0.96). A mean Lambda of 0.92 for 11 sub-populations over 3 – 18 years resulted in a 57% decline in Alberta. A Lambda < 0.9 equates to 50% decline in 7 years. An ongoing decline of >30% of the BP is inferred. Caribou populations fluctuate over time but it is doubtful that populations will increase in the approximately 35% of the range and 32% of the population where disturbance levels are at, or below, the disturbance thresholds for sustainability. The threats assessment also suggests that these populations will not increase.

Threats and Limiting Factors

The primary threat to Caribou persistence is habitat loss and excessive mortality rates, factors which often interact because predation increases in disturbed areas. Cumulative anthropogenic (e.g. natural resource extraction and development, roads), and natural disturbances (e.g. forest fire, blowdown) are associated with avoidance behaviour, and decreased recruitment because of increased predation rates. Forest-clearing activities (e.g. forestry, oil and gas development) increases the abundance of alternate prey (e.g. Moose, deer), which can cause increased mortality rates on Caribou. Predation is considered a major proximate threat to Caribou in developed regions of the BP, and in all of GP, and of unknown, but likely lower, significance in the NP. In NP, disturbance appears less significant because fires are rare and much of the range has relatively minimal forestry or mining activity. Throughout the BP distribution, the levels of anthropogenic disturbance indicates that ranges are not self-sustaining, without intervention, across much of the southern half of BP range. Parts of BP range in their northern distribution in NT, Ontario, Québec, and Labrador are disturbed by fire, but are currently relatively less affected by anthropogenic disturbance. A large area in the NT range was burned in 2014 and the range quality has decreased and needs to be assessed. Relatively less is known about the BP in Saskatchewan and Manitoba. In some regions, overhunting poses a threat for long-term conservation. In GP, increased predation rates are believed to be related to anthropogenic disturbance in areas adjacent to the GP. Recreational activities (e.g., snowmobiling, hiking, skiing and cabins) are a concern in parts of each DU range, and of particular concern in the small isolated GP. Natural factors, such as climate change and environmental disturbance, can impact Caribou habitat. The NP, BP, and GP are all associated to varying extents with mature - old coniferous stands, which are subject to fire events that are likely to increase in the future, particularly in the BP range. Disease impacts are less well known but there are concerns over spread of brainworm in parts of BP range and several pathogens in BP and GP range.

A threats assessment concluded that the overall threat is High-Medium for the NP, Very High-Very High for the GP, and Very High-High for the BP.

Protection, Status, and Ranks

COSEWIC assessed the conservation status of NP in 1984, 2000, and 2002, and recommended that this population was Not at Risk. The NP was ranked as S4 in 2012 at the provincial level. In NP, large areas exist which are of marginal timber value and are not in imminent danger of being disturbed by industrial activity. The GP was designated as

Threatened in 1984 and re-examined and uplisted to Endangered in 2002. The status for GP in Québec is threatened (note: this is the highest category of endangerment). Nature Serve labelled GP as critically imperilled (N1). Most of the GP range is contained within Gaspésie Park and in the Matane and Chic-Chocs Wildlife Reserves. The BP was first assessed in 2000 by COSEWIC and listed under SARA as Threatened, which was reconfirmed in 2002. Boreal Caribou are listed as Vulnerable (near-equivalent to 'Threatened' in COSEWIC) in Québec, Threatened in Labrador, Ontario, and NT, and Threatened in Manitoba. Boreal Caribou are Red-listed in BC, and Not at Risk in Yukon, and Saskatchewan. The Nature Serve rank is N4 (2011) nationally, and ranks at the provincial scale range from S1 to S4. Forest management plans have been modified to assist Caribou in parts of all three DUs, but implementation is variable and efficacy unknown to date. Predator control has been applied annually since 2001 in the GP, and in parts of the BP. In the NP, hunting of Black Bear and Coyote occurs but direct predator control is not applied.

TECHNICAL SUMMARY - Newfoundland population

Rangifer tarandus

Caribou - Newfoundland population — Caribou - Population de Terre-Neuve

Range of occurrence in Canada: Newfoundland & Labrador

Demographic Information

Generation time Using life table parameters, generation length was estimated at 6.2 years for the NP and rounded off to 6 years	6 years
Is there an observed continuing decline in number of mature individuals? 9% annual decline from 2000-2006, and 5% since 2007.	Yes
Estimated percent of continuing decline in total number of mature individuals within 2 generations (12 years; 2001-2013). Estimate of 68880 mature Caribou in 2001, and 28241 in 2013, based on calf recruitment rates.	58%
Estimated percent reduction in total number of mature individuals over the last 3 generations (18 years; 1995-2013). Estimate of 74912 mature Caribou in 1995, and 28241 in 2013.	62%
Projected percent reduction or increase in total number of mature individuals over the next 3 generations (18 years). Population Viability Analysis (PVA) estimated that if conditions remain unchanged, the NP will decline at a mean annual rate of 5.1% from 2011 to 2030. If hunting is stopped, the NP will decline at -3.5%. If calf survival increases to 49%, PVA predicted that population will increased by 2.9% per year.	-5.1% per year (status quo) -3.5% per year (no hunting) +2.9% per year (increased calf survival)
Percent increase in total number of mature individuals over any 3 generations (18 years) period, over a time period including both the past and the future. Observed declines of 58% in last 2 generations could improve or worsen in next generation, depending upon management (see above)	Unknown
Are the causes of the decline clearly reversible, understood, and ceased? Causes of the decline understood and possible additive predation likely ceased. The proximal cause is related to calf predation while density-dependence may have been the ultimate factor. Population decline was exacerbated by a delay in hunting reduction. Population is showing signs of recovery from density-dependence effects.	Likely

Are there extreme (i.e., >10X) fluctuations in number of mature individuals? Decline occurred in the early 1900s and Caribou persisted at low densities before increasing from 16589 to 68880 during 1975-1993 (4.15X), then declining to 28241 in 2013 (- 2.44X).	No

Extent and Occupancy Information

Estimated extent of occurrence Caribou can be found in a large portion of the island.	112,000 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	44,781 km²
Is the population severely fragmented? Some sub-populations are relatively isolated but most of the population is in close proximity and movement corridors exist for parts of the range	No
Number of locations* About 14 subpopulations (native and relocated) exist on the island of Newfoundland. Possible exchange exists between most of these sub-populations but no single threat impacts all sub-populations equally.	>14
Is there an observed continuing decline in extent of occurrence? The distribution of Caribou has shifted through time. Many sub-populations have been introduced and this has artificially increased the extent of occurrence.	Unknown, but probably limited in scale
Is there an observed continuing decline in index of area of occupancy? See previous comments.	Unknown, but probably limited in scale
Is there an observed continuing decline in number of populations? Not in the last decade.	No
Is there an observed continuing decline in number of locations?	No
Is there an observed continuing decline in extent and/or quality of habitat? Human footprint in the NP range is relatively low compared to BP and GP; forest harvesting has decreased in recent years. Many Caribou are not dependent upon mature forests that may be cut. Impact of Coyote predation not apparent but of concern.	No
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations?	No

* See definitions and Abbreviations on COSEWIC website and IUCN 2010 for more information on this term.

Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	N Mature Individuals
Total	Est. 28241
NP population estimated at 31,980 caribou in 2013. Mature population estimated at 28,241, using mean calf recruitment values from 2003-2011.	

Quantitative Analysis

Probability of extinction in the wild is at least 20% within 5 generations (30 years). Population Viability Analysis (PVA) indicates decline by 90% is possible if recruitment is low, but the probability of extinction by 2030 was zero under all three scenarios.	No

Threats (actual or imminent, to populations or habitats)

- Direct and functional loss of habitat due to disturbances from resource extraction activities is possible though lack of Wolves likely limits the impact of anthropogenic disturbance.

- Increased levels of predation is a concern if Coyote populations increase. Wolves may establish, but are not likely.

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? The DU only exists within Canada	n/a
Is immigration known or possible?	n/a
Would immigrants be adapted to survive in Canada?	n/a
Is there sufficient habitat for immigrants in Canada?	n/a
Is rescue from outside populations likely?	n/a

Data-Sensitive Species

Is this a data-sensitive species?	No

COSEWIC Status History

Newfoundland population was designated Not at Risk in April 1984. Status re-examined and confirmed in May 2000 and in May 2002. Status re-examined and designated Special Concern in November 2014.

Status and Reasons for Designation:

Status: Special Concern	**Alpha-numeric code**: Not applicable
Reasons for designation: This population was last assessed as Not at Risk in 2002 when the population was 85,000. This population has fluctuated in abundance over the last 100 years and presently has declined by approximately 60% over the last 3 caribou generations. The decline was due to limited forage when the population was at high density, harvest, and predation. Various indices suggest that the population is improving but there is concern that Eastern Coyote, which has recently arrived on Newfoundland, may become a significant predator and influence recruitment such that the population continues to decline.	

Applicability of Criteria

Criterion A: Not applicable. Recent declines may be associated with natural fluctuations, which do not qualify under IUCN guidelines
Criterion B: Not applicable. EO, IAO, and number of locations exceed criteria thresholds.
Criterion C: Not applicable. Population of mature animals exceeds criterion threshold.
Criterion D: Not applicable. Population exceeds criterion threshold.
Criterion E: Not applicable. A PVA identified decline but not extinction. Outcome is strongly dependent on recruitment rates, which can change due to management actions.

TECHNICAL SUMMARY - Atlantic-Gaspésie population

Rangifer tarandus

Caribou – Atlantic-Gaspésie population

Caribou – Population de la Gaspésie-Atlantique

Range of occurrence in Canada: Québec

Demographic Information

Generation time No age data are available for GP, therefore the average age of the Newfoundland population is used.	6 years
Is there an observed continuing decline in number of mature individuals?	Yes
Estimated percent of continuing decline in total number of mature individuals within 2 generations (12 years; 2001-2013). The 12-year trend (2001-2013) = +13% but the value varies in a fluctuating population, depending on any 12-year period used. Therefore, an average 12-year period decline was determined from 5, 12-year periods within 1997 – 2013. There has been a 49% decline since 1983 (30 years).	Average of 10% for 5, 12-year periods (range +1 to -47%)
Observed percent reduction in total number of mature individuals over the last 3 generations (18 years; 1996-2013). The 18-year trend (1996-2013) = -25% but the value varies in a fluctuating population, depending on year used. Therefore, an average 12-year period decline was determined from 5, 18-year periods within 1991-2013. There has been a 49% decline since 1983 (30 years).	Average of 11% for 5, 18-year periods (range +15 to -34%)
Projected percent reduction in total number of mature individuals over the next 3 generations (18 years; 2013-2031). Potentially extirpated in 21 yrs (2034) if calf mortality remains at average rates.	Unknown
Observed and predicted percent reduction in total number of mature individuals over any 3 generations (18 years) period, over a time period including both the past and the future. Management actions may influence calf survival.	Unknown
Are the causes of the decline clearly reversible and understood and ceased? Decline due to habitat loss and predation, which have lessened due to management, but continue to be a threat.	No
Are there extreme (i.e., > 10X) fluctuations in number of mature individuals? Population does oscillate by 30-60%.	No

Extent and Occupancy Information

Estimated extent of occurrence	About 1500 km²
Index of area of occupancy (IAO)	<1000 km²

(Always report 2x2 grid value).	
Is the population severely fragmented? Since 1975, no evidence of tagged caribou moving between the three summit sub-populations	Likely
Number of locations* The GP is composed of three sub-populations which experience different predation, recreation, and adjacent land use impacts.	3
Is there an observed continuing decline in extent of occurrence?	No
Is there an observed continuing decline in index of area of occupancy?	No
Is there an observed continuing decline in number of populations?	No
Is there an observed continuing decline in number of locations?	No
Is there an observed continuing decline in extent and/or quality of habitat? Forest harvest and roads in area facilitated increased density of prey for Coyote and Black Bear, which results in lower calf recruitment. Anthropogenic disturbance levels (75%) continue to exceed sustainability threshold (35%) but new forest regulations and predator control should lessen impact of predators	Yes
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	N Mature Individuals
Total In 2012 and 2013, the population of mature Caribou was estimated at 65 and 112 animals, respectively.	112

Quantitative Analysis

Probability of extinction in the wild is at least 20% within 5 generations (30 years). Population Viability Analysis estimated that if calf recruitment remains at the mean level observed from 2009 to 2011, the average time to extirpation is 20.5 years and all simulation models predict extinction by 2056.	Yes

* See definitions and Abbreviations on COSEWIC website and IUCN 2010 for more information on this term.

Threats (actual or imminent, to populations or habitats)

Habitat loss and predation by Coyotes and Black Bears are the main threats to the persistence of the GP. Predators are supported by habitat alteration, mainly from logging, that occurs outside the park. Wind energy farms are a concern.

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? The DU only exists within Canada	n/a
Is immigration known or possible?	n/a
Would immigrants be adapted to survive in Canada?	n/a
Is there sufficient habitat for immigrants in Canada?	n/a
Is rescue from outside populations likely?	n/a

Data-Sensitive Species

Is this a data-sensitive species?	No

COSEWIC Status History

Atlantic-Gaspé ... population designated Threatened in April 1984. Status re-examined and designated Endangered in May 2000. Status re-examined and confirmed in May 2002 and November 2014.

Status and Reasons for Designation:

Status: Endangered	**Alpha-numeric code**: B1ab(iii,v); C2a(i); D1; E
Reasons for designation: This small isolated population has declined to fewer than 120 adults. Historically, these caribou were much more widely spread, occurring in New Brunswick, Nova Scotia, and Prince Edward Island. Today, they mainly use alpine habitats on mountain plateaus in the Gaspésie region, in Quebec. Habitat has been modified by resource development, including forest management that reduced forest age, and increased density of predators of caribou. Adult mortality and continued low calf recruitment due to Eastern Coyote and Black Bear predation are contributing to an ongoing decline. Population models predict the population may become extinct by 2056.	

Applicability of Criteria

Criterion A: Not applicable; Although there is a decline of 49% over a 30-year period, the averaged decline over 3 generations (11%) is above criterion threshold.
Criterion B: Meets B1ab(iii,v) Endangered: Extent of occurrence (1500 km²) is below threshold for Endangered (5000 km²) and population exists in < 5 locations wherein habitat is projected to decline and number of mature individuals is declining.

Criterion C: Meets C2a(i) Endangered: Total population (112) is below threshold for Endangered (250) and population is declining.
Criterion D: Meets D1 Endangered: Population (112) is below threshold for Endangered (250 mature animals).
Criterion E: PVA indicted high probability of extirpation by 2056 dependent on the extent of management activities (e.g. predator control) that affect recruitment.

TECHNICAL SUMMARY - Boreal population

Rangifer tarandus

Caribou – Boreal population — Caribou – Population boréale

Range of occurrence in Canada: Newfoundland & Labrador, Québec, Ontario, Manitoba, Saskatchewan, Alberta, British Columbia, and Northwest Territories (extending slightly into the Yukon)

Demographic Information

Generation time No age data are available for BP, therefore the average age of the Newfoundland population is used.	6 years
Is there an observed or inferred continuing decline in number of mature individuals? Past population size is not known well enough for most of total range but declines have been recorded in parts of the range. Inferred decline is based on disturbance and probability of decline; of 50 Boreal Caribou ranges assessed, the Federal Recovery Strategy reported that 35% of BP area, and 32% of the population were not, or possibly not, self-sustaining. Population growth rates exist for 37 sub-populations, covering >90% of the range; 81% of which had negative finite growth rates.	Yes
Estimated percent of continuing decline in total number of mature individuals within 2 generations (12 years; 2001-2013). See above	Unknown; declining in one-third of range
Estimated and suspected percent reduction in total number of mature individuals over the last 3 generations (18 years; 1995-2013). See above	Unknown; declining in one-third of range
Suspected percent reduction in total number of mature individuals over the next 3 generations (18 years). Based on negative Lambda levels in most sub-populations, and non-sustainable ranges in 1/3 of range and population, an estimate of > 30% decline in population is predicted. (Note: a Lambda <0.90 equals 50% decline in 7 years). Given current habitat trends and population trajectories, continued declines are projected.	>30 %
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any 3 generations (18 years) period, over a time period including both the past and the future. Based on observed declines, expected declines associated with negative Lambda values from 81% of 37 sub-populations, and that the majority of ranges are not, or possibly not self-sustaining suggests declines that have occurred in recent years will continue into the future.	>30%

Are the causes of the decline clearly reversible and understood and ceased? Most of the causes of the population declines are understood but not ceased. Habitat loss and disturbance occurs in most ranges. Management actions including predator and alternate prey control and resource management guidelines have been applied to varying degree, but their ability to reverse decline is yet to be confirmed.	No
Are there extreme fluctuations in number of mature individuals? Although no extreme fluctuations in number of Caribou occurred at the scale of the Canadian range, some ranges have experienced drastic declines in some provinces.	No

Extent and Occupancy Information

Estimated extent of occurrence	3 million km^2
Index of area of occupancy (IAO) (Always report 2x2 grid value). Source: Federal Recovery Strategy	2.45 million km^2
Is the population severely fragmented? Caribou are isolated and highly fragmented populations in British Columbia and Alberta. In the NT and from Manitoba to Labrador, most of the BP is dispersed in a continuous range. Some isolated populations exist south of the continuous range in Manitoba, Ontario, and Québec.	No
Number of locations* The Federal Recovery Strategy identified 51 Boreal Caribou ranges in Canada. Different threats exist in each range.	Many
Is there an observed continuing decline in extent of occurrence? A northward range contraction and range fragmentation has been described in most provinces over last hundred years and continues (e.g. Manitoba). The northward receding trend in the southern limit of BP range is a slow process (e.g. 34 km per decade in Ontario). Time lags on the order of decades between disturbance and range loss make it difficult to infer the boundary in some parts of Canada.	Yes
Is there an observed continuing decline in index of area of occupancy? See above	Yes
Is there an [observed, inferred, or projected] continuing decline in number of populations? One sub-population (Swan-Pelican Lakes) confirmed to be recently extirpated in Manitoba.	Yes

* See definitions and Abbreviations on COSEWIC website and IUCN 2010 for more information on this term.

Is there an [observed, inferred, or projected] continuing decline in number of locations*? See above	Likely
Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat? Habitat alteration through anthropogenic and natural disturbance has caused direct and indirect loss of habitat across Canada.	Yes
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy? Range recession has been consistent; extirpated areas have not been re-populated.	No

Number of Mature Individuals (in each population)

Population	N Mature Individuals
Total Mature animal estimate includes unknown number of calves because some, but not all, jurisdictions include calves in estimate and definition of calf varies among surveys. Source: Environment Canada (2012).	Unknown; 33000-34000 (includes unknown # of calves)

Quantitative Analysis

Probability of extinction in the wild is at least 20% within 5 generations (30 years).	Not done

Threats (actual or imminent, to populations or habitats)

Most habitat disturbances within BP ranges remove mature coniferous forests and create young stands of mixed forests. This new landscape favours population increases of other cervids (Moose and White-tailed Deer), and subsequently facilitates population increases of predators like Wolves and Black Bears. Threats are closely interrelated and act cumulatively to cause direct and indirect impacts on BP. Caribou avoid areas with anthropogenic disturbance, such as roads, linear features, noise, and land clearing. An increase in fire will result in habitat loss. Some local sub-populations are at risk due to overhunting, pathogens, and climate change.

* See definitions and Abbreviations on COSEWIC website and IUCN 2010 for more information on this term.

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? The DU only exists within Canada	n/a
Is immigration known or possible?	n/a
Would immigrants be adapted to survive in Canada?	n/a
Is there sufficient habitat for immigrants in Canada?	n/a
Is rescue from outside populations likely?	n/a

Data-Sensitive Species

Is this a data-sensitive species?	No

COSEWIC Status History

The Boreal population was designated Threatened in May 2000. This newly defined population is composed of a portion of the de-activated "Western population" and all of the de-activated "Labrador-Ungava population". Status re-examined and confirmed in May 2002 and November 2014.

Status and Reasons for Designation:

Status: Threatened	**Alpha-numeric code**: A3bc+4abc

Reasons for designation:
This population occurs at naturally low densities in mature boreal forest habitats from Labrador to Yukon, with small, isolated populations at the southern part of the range, including along the Lake Superior coastline and in the Charlevoix region of Québec. Over the past century, local subpopulations have been lost; range contraction has proceeded from the south by up to 50% of historical range in some areas. Despite considerable conservation efforts, range-wide declines have continued since the last assessment in 2002, particularly in Alberta, northeastern British Columbia, and Labrador. Some populations remain poorly monitored, particularly those in the northern portion of the range. For 37 of 51 subpopulations where trend data are available, 81% are in decline, as indicated by negative population growth rates. Some of the most intensively managed subpopulations may remain critically imperiled. Reasons for decline are mainly due to increased predation and habitat loss, the latter stemming from the combination of anthropogenic (natural resource extraction) and natural (fires) disturbance. The proliferation of linear landscape features such as roads and seismic lines facilitates predation by wolves, and the conversion of mature – old conifer stands to younger seral stages promotes increases in alternate prey such as Moose and White-tailed Deer. Shifts in the northern distribution of White-tailed Deer, mediated by landscape change, also bring novel parasites into parts of the range of this population. In some regions, overhunting poses a threat to long-term conservation. Threats are closely interrelated and act cumulatively to impact this population. Population increases do not appear likely in one-third of subpopulations where disturbances exceed a threshold of viability. A >30% decline in population is projected in the near term.

Applicability of Criteria

Criterion A: A1 Not applicable; Threats not ceased. A2 Not applicable; Past population abundance poorly known and declines inferred from negative growth rates mainly from last 10 years, rather than 18 years. A3bc Meets Threatened; Reductions of > 30% expected in the population in next 18 years, based on evidence that most of range has negative growth rates and future population increase is not expected in the approximately 35% of ranges where disturbance is at or below self-sufficiency threshold. A4abc meets Threatened; as above, with additional direct observation of declines in sub-populations in British Columbia, Alberta, Labrador in last 10 years, and expectation of continued declines due to negative growth rates and amount of range at or below self-sufficiency threshold.
Criterion B: Not applicable; range exceeds 20,000 km².
Criterion C: Not applicable; population exceeds 10,000 mature animals.
Criterion D (Very Small or Restricted Population): Not applicable; Population exceeds 1,000 mature animals, with > 5 locations.
Criterion E: Not applicable; population viability analysis for most of DU not conducted.

PREFACE

Six "nationally significant populations" of the forest-dwelling Woodland Caribou were identified by COSEWIC in 2002 and listed under SARA as: Northern Mountain population (Special Concern), Southern Mountain population (Threatened), Boreal population (Threatened), Forest-tundra population (Not Assessed), Atlantic-Gaspésie population (Endangered), and the insular Newfoundland population (Not at Risk) (COSEWIC 2002). In 2011, COSEWIC adopted a designatable unit structure for all Caribou in Canada (COSEWIC 2011); the Boreal population (DU6), the Atlantic-Gaspésie population (DU11) (referred to as Gaspésie population in this report), and the insular Newfoundland population (DU5) are assessed in this report.

Since the last assessment, there have been significant amounts of research in all three DUs, much of it in support of provincial and national recovery efforts. Information for the three DUs is presented together unless it is unique to a DU, or relates to a subject more important for assessment. Available information is not equal between, or within, DUs, and more detail exists in some sections of the report.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2014)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment Canada | Environnement Canada
Canadian Wildlife Service | Service canadien de la faune
Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Caribou
Rangifer tarandus

Newfoundland population
Atlantic-Gaspésie population
Boreal population

in Canada

2014

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Class: Mammalia

Order: Artiodactyla

Family: Cervidae

Scientific name: *Rangifer tarandus* (Linnaeus 1758)

Common Names: Caribou (English and French); Qalipu/Xalibu (Mi'kmaq); Minunasawa atikw (Innu); Ahtik/Atik (Cree); Tǫdzi (Tłı̨chǫ); T'onzi/Tohzi (North Slavey); Vadzaih (Gwichin); Ch'atthaii (Vuntut Gwichin); (see COSEWIC 2012 regarding Aboriginal names).

Caribou are an inseparable component of many Aboriginal societies and the species has names in many languages. COSEWIC (2012) contains an extensive list of Caribou names used with permission from Aboriginal traditional knowledge (ATK) collection exercises. Reindeer is the common name in Eurasia. Reindeer have been introduced in some parts of Alaska and Newfoundland. All Caribou and Reindeer, despite physical differences like size and colouration, are the same species and able to interbreed and produce fertile offspring.

Terminology in Caribou ecology is complex and confusing because similar terms (e.g., woodland, boreal, and forest-dwelling) have been used to describe ecotypes and subspecies interchangeably. This report follows the designatable unit (DU) structure outlined in COSEWIC (2011). The Boreal population (BP) refers to 'Boreal Caribou' (Environment Canada 2012) or relatively non-migratory Caribou ('sedentary ecotype') of mainly forested regions (COSEWIC 2011). Within each DU, the term 'Caribou' refers to information collected within that DU, unless otherwise noted. Thus, 'Caribou' in the BP DU refers to Boreal or Woodland Caribou (*sensu* Banfield 1961), unless otherwise noted. Regulations within the BP DU often apply to 'Boreal Caribou' and this term is used if regulations are discussed.

Morphological Description

Caribou exhibit tremendous variation in morphology, ecology, and behaviour across their range (Geist 1998). Caribou are medium-size deer with relatively long legs, large crescent-shaped hooves, and broad muzzles with large nostrils. Both hooves and muzzles are covered by hairs as adaptations to cold. The hooves constitute one of the most obvious adaptations to their environment: they are very large and often wider than they are long, and thus are well-suited to walk on deep soft snow, dig through crusted snow for winter forage, and swim across large or turbid bodies of water. Caribou are the strongest swimmers among the deer family (Kelsall 1968; COSEWIC 2012). A Pikangikum elder noted that:

"When they fall through the ice ... they have the ability to get out of the water because of the way their hooves are structured... When there is no snow on the ice, the caribou can run... It will not slip. It is even able to gallop..." (O'Flaherty *et al.* 2007).

Coat colouration varies seasonally and between DUs. NP Caribou have pale fur with a very long, white neck mane in bulls (see cover page) although their antlers are similar to those of the sedentary ecotype (Geist 1998). During winter, GP Caribou are pale grey or almost white, while in summer, the coat turns dark brown. During the rut, male bodies are brown with a very long beige mane and brown face (see cover page). BP Caribou typically are brownish-grey along the back, sides, and legs, and with white or pale underparts and rump. The genus *Rangifer* is the only cervid where females usually possess antlers, although they are smaller than male antlers. Antler appearance is highly variable between ecotype, sex, age, and reproductive season, and antler mass and size are sensitive to changing environmental and nutritional conditions (Bergerud *et al.* 2008).

Population Spatial Structure and Variability

Climate-driven range fluctuations during the Pleistocene epoch reshaped *Rangifer* distribution after the last glaciation (e.g., Grayson and Delpeche 2005; Sommer *et al.* 2011). A phylogenetic study by Røed *et al.* (1991) concludes that Caribou recolonized North America and Eurasia from at least two refugia: one north of the Beringia-Eurasia ice sheet and one south of the North American ice sheets (Yannic *et al.* 2013). Flagstad and Røed (2003) suggested that the North America refugium was composed of several separate refugial populations, which was confirmed by a recent phylo-geographical analysis that suggested that postglacial expansion of Caribou dates back 14,000-22,000 years from three separate refugia located south of the ice sheets: the Rocky Mountains; east of the Mississippi; and the Appalachian Mountains (Klütsch *et al.* 2012). These separate refugia corresponded to distinct genotypic lineages that diverged before the last glacial maximum (38,000-48,000 years).

All three DUs were named by Banfield (1961) as part of the same subspecies, *Rangifer tarandus caribou*; but Newfoundland Caribou were considered a distinct subspecies (*R. t. terraenovae;* Bangs 1896) until the reclassification by Banfield (1961). Geist (2007) proposed retention of subspecies status for NP Caribou based on nuptial characteristics (coat colour, antler shape). The population does contain several haplotypes not found in other *Rangifer* populations (Cronin *et al.* 2005) but the subspecies issue is not resolved. Within the NP, mtDNA analyses suggest there is minor genetic structure, except between the sub-population on the Avalon Peninsula and remaining sub-populations (Wilkerson 2010).

COSEWIC uses the term 'sub-population' for populations within a species' or DU range. In Caribou literature, other terms, such as herd, range, and local population are often used for groupings below the DU level. Delineation of these 'sub-units' can be difficult (Environment Canada 2011; Nagy 2011). In BP Caribou, sites are reused annually but females disperse from one another at calving, and population structure can be described as

a continuum of local populations or groups of Caribou that may exchange a small percentage of individuals within the continuous range and change areas over time (Couturier *et al.* 2009). Delineating populations in the BP range is thus a challenge, and Schaefer *et al.* (2001) proposed the use of fuzzy cluster classification to identify the spatial structure of populations. Fuzzy cluster analysis allows group identity to be a matter of degree of membership (Schaefer and Wilson 2002), which fits well to the ecology of the BP. Using the same methods, Rudolph et al. (2012) confirmed the spatial structure of three populations in northern Québec. Nagy (2011) identified two populations in the NT; however, these clusters may have been an artefact of lack of data from the centre of the NT range. BP are treated as one continuous distribution of individuals within their range in the NT (NT Species at Risk Committee 2012). When a local population becomes isolated, the population structure changes from a diffuse continuum of individuals to a distinct group that lacks movement between groups. Thus, distinct BP local ranges, such as in Alberta, are likely a product of anthropogenic landscape disturbance as opposed to how the animals organize themselves on an intact landscape.

Delineation of GP and NP Caribou into identifiable subpopulations is less of a concern because a large proportion is restricted to mountain tops (GP) or plateaus (NP), and both generally use more open habitat (see **Habitat Use** section).

For the BP, the Federal Recovery Strategy, developed in association with provincial agencies, recognizes population ranges, defined as the geographic area occupied by a group of Caribou subject to similar factors affecting their demography and used to satisfy their life history processes over a defined time frame (Environment Canada 2012). Within the population range, three types of ranges were identified based on the certainty of their boundary delineation: 'conservation unit' (low certainty); 'improved conservation unit' (medium certainty); and 'local population unit' (high certainty). 'Local population' refers to a group of Boreal Caribou occupying any of the three types of Boreal Caribou ranges (Environment Canada 2011, 2012). Some of these ranges are remnant, isolated populations and easily delineated (*i.e.*, Coastal Range in Ontario, Charlevoix Range in Québec, Little Smoky in Alberta), while most others exist in a continuous distribution and are less easily delineated (e.g., 'improved conservation units' in Ontario; OMNR 2014; Elder pers. comm.). The term 'herd' is used in the GP and NP (Weir *et al.* 2013).

Designatable Units

Twelve DUs (one extinct) were defined for Caribou in Canada based on guidelines proposed in COSEWIC (COSEWIC 2011). DU delineation was based on five lines of evidence: (1) phylogenetics; (2) genetic diversity and structure; (3) morphology; (4) movements, behaviour, and life history strategies; and (5) distribution (COSEWIC 2011). Isolated sub-populations are located in BC, Alberta, Ontario, and Québec but these are not valid DUs because they exist due to anthropogenic disturbances, rather than as a DU that has evolved from local conditions (Environment Canada 2012). This report will assess the status of three DUs of Caribou: the Newfoundland population (NP); Gaspésie population (GP); and the Boreal population (BP). The NP is identified as a DU based on evidence of phylogenetic divergence and genetic discreteness from mainland populations due to

isolation, as well as distinctive morphology. The GP is identified as a DU based on genetic differentiation from nearest DUs, facilitated by the movement barrier of the St. Lawrence River, and its status as the last sub-population from the Maritime region. The BP is identified as a DU based on aggregation and migration strategies adapted to the boreal forest landscape, and a lack of genetic flow between adjacent Caribou DUs (COSEWIC 2011).

Special Significance

Caribou play a significant role in the ecology, economy, and culture of much of Canada (Festa-Bianchet *et al.* 2011). This animal was the most abundant large mammal in much of its range, providing food, tools and clothes to people for thousands of years (Gordon 2003). Caribou continue to play a vital role in societal cohesion and form the basis of many legends and spiritual practices that depict the strong relationships linking Caribou and Aboriginal people (Hummel and Ray 2008; Vors and Boyce 2009). For example, a Gwich'in elder living in the Yukon explained that Caribou and Gwich'in always carry a part of one another's hearts deep within them; she added that Caribou blood runs through her blood and that of all Arctic peoples (Hummel and Ray 2008). Caribou are hunted for subsistence and sport hunting, both of which generate significant economic contributions (Wells *et al.* 2011).

Caribou have been proposed as a keystone species of the boreal forest because of their role as a prey species, and because of their impact on vegetation and nitrogen cycling (Festa-Bianchet *et al.* 2011). Maintaining a healthy Caribou presence in the boreal ecosystems may therefore ensure that their biodiversity is perpetuated while maintaining their ecological services (Fortin *et al.* 2011).

DISTRIBUTION

Global Range

Rangifer has a widespread circumpolar distribution in boreal, subarctic, and arctic biomes. Most Reindeer populations are found in Norway, Sweden, Finland, and Russia, while Caribou occupy large portions of northern Canada, Greenland and Alaska. The three DUs are found entirely within Canada although the southern portion of the BP/GP was in the northern United States; Caribou disappeared from Wisconsin, Vermont, Maine, and New Hampshire by the turn of the 20th century (Banfield 1974).

Canadian Range

Newfoundland population

Caribou originally inhabited the entire island of Newfoundland, although three areas of higher abundance were identified in the early 20th century: the Humber River Valley; the central portion of the island south of the railway; and the Avalon Peninsula (Prichard 1910,

cited in Banfield 1961). Twelve Caribou sub-populations were present before additional sub-populations were established through a series of relocations made in the 1960s-70s (Mercer *et al.* 1985). Up to 36 sub-populations have existed (Figure 1) but there appear to be approximately 14 sub-populations presently (Pardy Moores pers. comm.). Shifts in Caribou occupancy have been observed in some sub-populations; anecdotal evidence suggests that a small number of Caribou have begun to reoccupy areas (NLDEC, unpubl. data 2013).

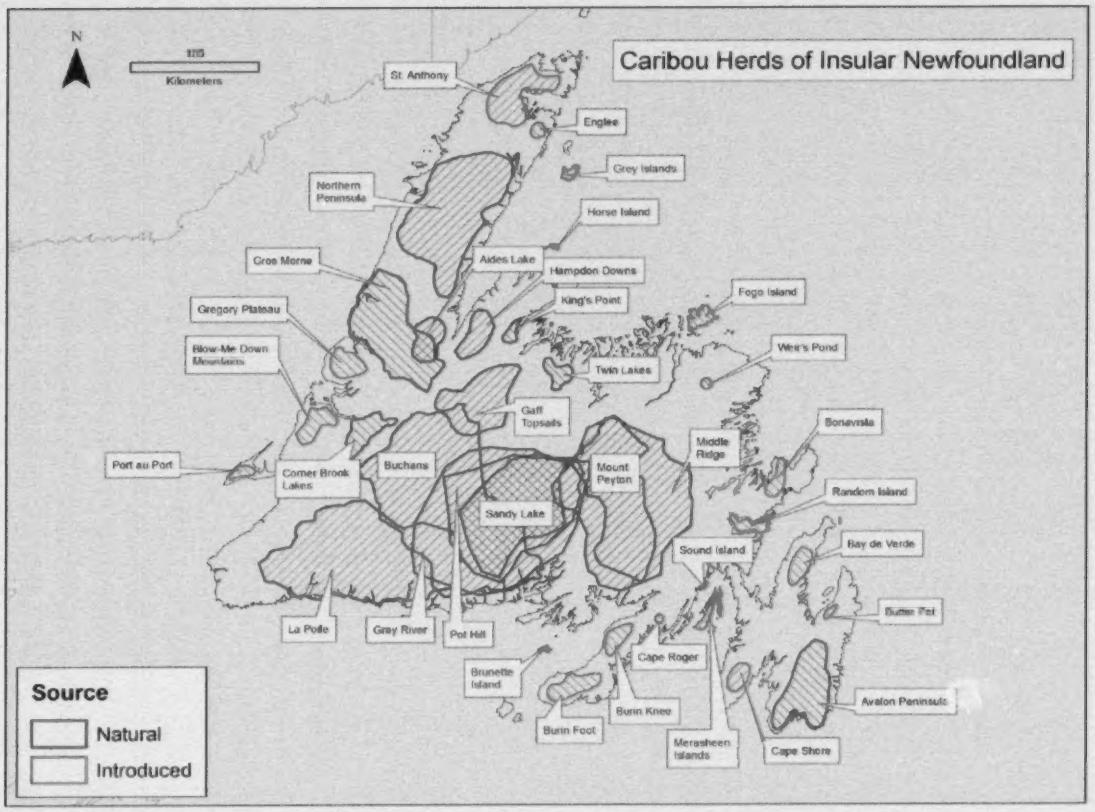

Figure 1. Distribution of 36 Caribou sub-populations across the island of Newfoundland during the 1990s. Major Caribou sub-populations (naturally occurring subpopulations) are shown in black and sub-populations relocated are shown in purple. Approximately 14 sub-populations are present as of 2013. Source: NLDEC, unpub. data).

Gaspésie population

In the 19th century, Caribou were found in New England and the Canadian Maritime Provinces. Caribou were extirpated from Prince Edward Island in 1874, from Nova Scotia in 1925, and from New Brunswick in 1927 (Banfield 1974; Bergerud and Mercer 1989). COSEWIC (2012) reported from ATK that Nova Scotia Caribou had been adversely

impacted by railroad establishment across migration routes. The southern limit of Caribou range gradually receded northward and the GP became the only remnant Caribou population south of the St. Lawrence River. In the mid-19th century, Caribou were irregularly present throughout the Gaspésie Peninsula, from the town of Gaspé to the east, to the Matapédia valley to the west, and south to the Baie des Chaleurs, an area spanning approximately 30,000 km^2 (Guay 1983; St-Laurent *et al.* 2009). By 1953-1955, Caribou range was mainly confined to higher elevation areas. The GP is currently found mostly on the McGerrigle and Chic-Chocs Mountains, and are largely confined to Gaspésie National Park (802 km^2) (Figure 2). The proportion within the Park was > 75% in the 1950s (Moisan 1958), 91% during 1987-1992 (Ouellet *et al.* 1996), and 83% during 1998-2001 (Mosnier *et al.* 2003).

The GP may be divided into three sub-populations, each associated with different mountain summits: Mount Logan, Mont Albert, and the McGerrigle Mountains (Figure 2; see Dispersal and Migration section – Gaspésie population). The McGerrigle Mountains sector includes Mount Jacques-Cartier and Mount Vallières-de-Saint-Réal.

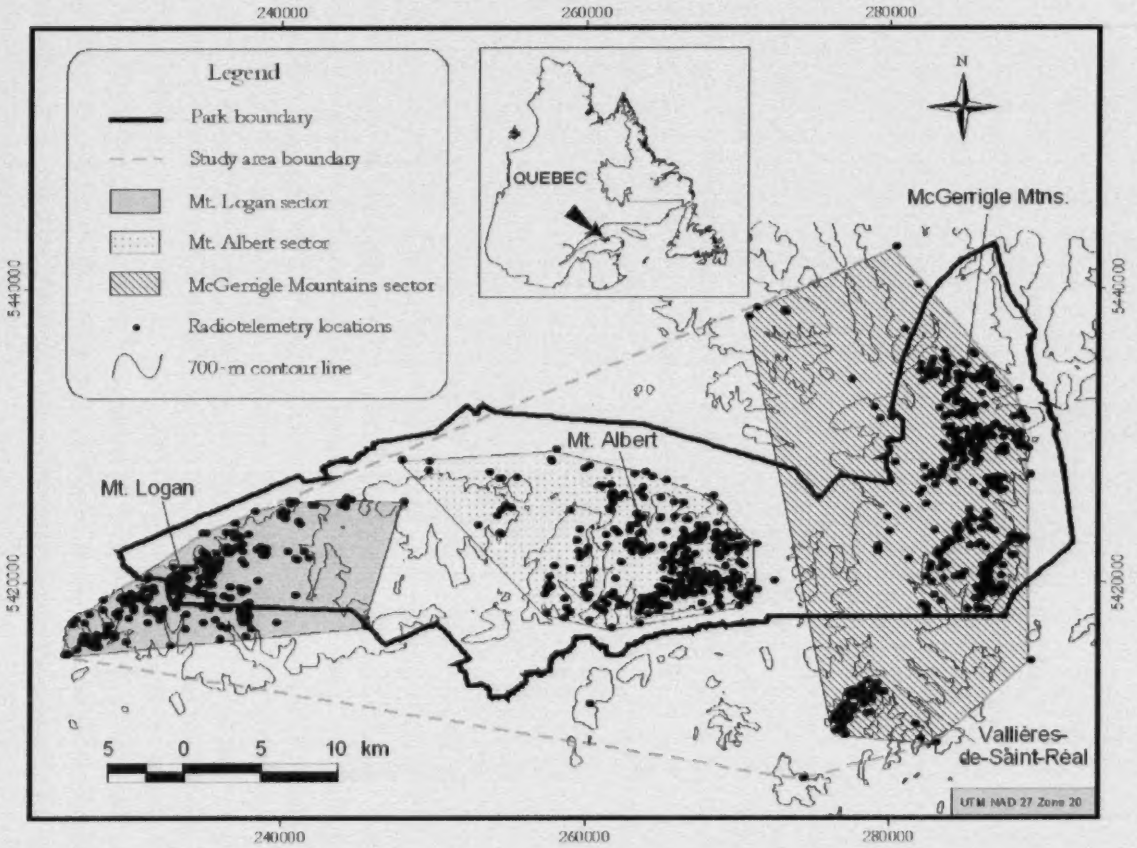

Figure 2. Gaspésie National Park and distribution of the three Gaspésie Caribou sub-populations of the Gaspésie designatable unit. Source: Mosnier *et al.* (2003).

Boreal population

Boreal Caribou occupy boreal forests from Labrador to eastern Yukon. In the northern portion of their range, the BP overlaps with the Eastern migratory (DU4) and Barren-ground (DU3) designatable units. For example, in northern Ontario, forest-associated Caribou have moved north, and tundra-associated Caribou have moved south during winter (Abraham *et al.* 2012; Wilson 2013). Boreal Caribou are found in three large ecozones including the Boreal Shield, the Boreal Plains, and the Taiga Plains ecozone (Wiken 1996). Together, these ecozones cover more than 3 million km^2, stretch more than 4,000 km across Canada, and encompass more than one third of Canada's land mass (Wiken 1996). In British Columbia (BC), Northwest Territories (NT), and the Yukon, the ranges of the BP adjoin with those of the Northern Mountain designatable unit (DU7).

Caribou are extirpated from half of their historic range in Canada in a pattern that mirrors the last century's expansion of human settlement and resource exploitation (Laliberté and Ripple 2004). Caribou are extirpated from approximately 60% of their historic range in Alberta, 50% in Ontario, and 40% in BC (Hummel and Ray 2008). In Quebec, Caribou have been extirpated from the southern townships and north to the 50^{th} parallel, except for a few isolated sub-populations (Courtois *et al.* 2003a). The Charlevoix sub-population, which had a population of 10,000 in the 19^{th} century was extirpated by hunting and poaching by 1920, before a reintroduction in the 1960s (St-Laurent and Dussault 2012). In Ontario, range recession has been documented for over 80 years (De Vos and Peterson 1951), and corresponds closely to the geography of human activity, particularly forest harvest (Schaefer 2003). The process of extirpation noted in northwestern Ontario (Racey and Armstrong 2000) likely exemplifies the process of range recession for the DU. In northwestern Ontario, over 150 years, Caribou declined in phases— there was a period of mature forest loss from large fires, forestry and agriculture, which resulted in remnant populations persisting in relatively inaccessible areas (e.g. poor quality soil, limited river access to remove timber). In the 1950s, forest access roads into these areas facilitated tree harvest, Wolf and human activity, and the spread of White-tailed Deer (and presumably Meningeal Brainworm, *Parelaphostrongylus tenuis*, which kills Caribou; see **Threats** – Problematic Native Species section). Ranges of the BP in Ontario have receded approximately 34 km per decade and the estimated time to extirpation, inferred from a sustained rate of disappearance, is 91 years (95% CI: 57-149 years) (Schaefer 2003).

The rate of this northward recession is not constant across BP range in Canada. Using range maps in COSEWIC (2011), the authors estimated the range contraction based on the historical distribution limit (estimated at 1850) and the current distribution limit (estimated at 2010). For five provinces, starting from Québec to Alberta, the authors computed northward recession rates of 36 (QC), 28 (ON), 14 (MB), 8 (SK), and 11 (AB) km per decade, respectively (BC was not included in this analysis). The northward BP recession has progressed at a greater rate than what would be expected from climate warming alone; on average, the loss of Caribou range attributed to climate change is approximately 6 km per decade (Parmesan and Yohe 2003). The observed range recession

(8-36 km per decade) is more plausibly linked to an increase in anthropogenic disturbances (see **Threats** section). Range recession continues, with Caribou recently confirmed as absent in the Swan-Pelican Lakes area, Manitoba (MBWCMC 2014).

As the range retracted northward, populations of Caribou became separated from contiguous Caribou range in Québec (e.g., Charlevoix and Val-d'Or), in Ontario (e.g., Lake Superior Coast Range, including Slate Islands, Michipicoten Island), and in Alberta (e.g., Little Smoky).

Extent of Occurrence and Area of Occupancy

The smallest range is the GP, which is estimated at 1500 km^2 (EO) and <1000 km^2 (IAO). The NP EO is much of the island, at 112,000 km^2. Combining telemetry locations (11,656 blocks or 13%) with "known caribou locations" (23,421 blocks or 27%) equals IAO of 35,077 blocks, or 44,781 km^2, approximately 40% of the island of Newfoundland. The BP EO encompasses much of Canada, at approx. 3 million km^2, and an IAO nearly as large at 2.45 million km^2.

Search Effort

The overall distribution of Caribou is well known. Delineating ranges for a highly mobile species like Caribou can be a difficult and expensive task. Consequently, budget constraints and large range size may preclude identification of some Caribou population ranges. The apparent large sizes of some Manitoba or Québec Caribou ranges should not be taken as a biological entity but may be simply an indication that more studies have yet to be conducted in these large, continuous ranges. For example, all BP Caribou in NT are delineated in a single distribution of 44.1 million ha, while the size of the Val-d'Or range is 347,000 ha (Environment Canada 2012). Five ranges were newly delineated in Ontario in 2012 and they reflect geographical units used for assessment purposes (improved conservation units), rather than discrete population ranges (Elder pers. comm.).

The NP and GP are more readily delineated because they occur in relatively smaller areas and the high proportion of radio-collared animals has facilitated documentation of movement and distribution.

Although recent studies have improved our understanding of the spatial ecology of Caribou, most research has focused on females in order to find calving areas; relatively less is known about adult male space use.

Newfoundland population

The NP is one of the best-studied DUs in Canada (Mahoney and Weir 2009). Information on distribution, abundance, and annual movement has been collected since 1902 (Bergerud 1971), while scientific surveys began by the 1950s. In 1996, the Caribou Data Synthesis Project was initiated to centralize, compile, and evaluate all Caribou-related data from the 1950s to the 1990s. In the early 2000s, population monitoring revealed low

recruitment, which resulted in calf mortality research in 2003, followed by research on adult mortality and distribution. Current efforts to monitor the abundance of the NP involve mark-resight aerial surveys for each major sub-population at least once every 4 years.

Gaspésie population

The GP were studied in the 1950s (Moisan 1958; Bergerud 1973). Autumn aerial surveys have been conducted since the early 1970s in order to assess population size, as well as determine sex and age ratios. Aerial surveys have been conducted in the Mount Albert and McGerrigle sectors since the early 1970s, but more rigorous methods have been applied since 1983. Surveys in the Mount Logan sector began in 1997.

Radio-tracking of the GP was initiated between 1975 and 1977 using aerial surveys (Georges *et al.* 1976; Rivard 1978). From 1987-1992, 28 Caribou (mostly adult females and some calves) were monitored to study space and habitat use during a period of low recruitment attributed to high predation (Ouellet *et al.* 1996). Another 35 VHF radio-tagged adults of both sexes were monitored from 1998-2001 (Mosnier *et al.* 2003), and monitoring of 43 GPS radio-tagged adults began in 2013 (St-Laurent pers. comm.).

Boreal population

Relatively little scientific research was conducted on the BP prior to the 1990s, but hundreds of papers and reports have since been produced. Research has often focused on the interrelationships between anthropogenic and natural landscape disturbance, predation, survival, and habitat use. Much of the last decade's research was conducted in Alberta (e.g., Dyer *et al.* 2002; Latham *et al.* 2011b), Québec (e.g., Courtois *et al.* 2008; Fortin *et al.* 2008; Briand *et al.* 2009; Moreau *et al.* 2012; Lesmerises *et al.* 2013), and Ontario (OMNR 2014), but many projects are underway in most jurisdictions.

In Labrador, Schmelzer (2013) compiled a comprehensive synthesis of demographic data collected on three Caribou sub-populations since the 1970s. In Québec, research has quantified relationships between Caribou habitat selection, distribution, and anthropogenic disturbance (e.g., Courtois *et al.* 2002, 2008; Faille *et al.* 2010; Renaud *et al.* 2010; Fortin *et al.* 2011, 2013; Moreau *et al.* 2012; Pinard *et al.* 2012; Lesmerises *et al.* 2013). Data from radio-tagged Caribou during 2004-2011 were used to delineate local population ranges and examine habitat selection in the Cree territory in Québec (Rudolph *et al.* 2012).

In Ontario, most research since the 1990s has addressed conservation and management priorities. Radio-collaring had focused on individuals at the southern margins and central core of the continuous Caribou range (e.g., Brown *et al.* 2003; Elder pers. comm.). Shuter and Rodgers (2010) used movement data derived from 73 radio-collared Caribou from 1995-2008 to delineate demographic units, particularly along the southern range. More recent research has occurred across BP range in Ontario. A major collaborative research programme is underway among universities and government to evaluate alternative hypotheses regarding mechanisms that influence probability of Caribou persistence, such as apparent competition (see **Threats** section), predator road use, prey

escape, sensory disturbance, and energetics/nutrition (Elder pers. comm.; OMNR 2014). Study areas were selected for key habitat attributes (e.g., conifer cover, linear feature density, Wolf (*Canis lupus*) and Moose (*Alces alces*) density) (Rodgers *et al.* 2009). GPS telemetry data was being collected from 423 Caribou and 56 Wolves during 2009-2013 (Shuter pers. comm.). Extensive fecal surveys and systematic occupancy surveys have occurred over much of the range since 2009 (Elder pers. comm.; OMNR 2012).

Caribou research in Manitoba and Saskatchewan focused on range use, distribution, and movements (e.g., Rettie and Messier 2000; Arsenault and Manseau 2011; Arlt and Manseau 2011). Research in Manitoba has integrated genetic techniques to delineate local ranges and quantify genetic population structure (Ball *et al.* 2007; 2010, Galpern *et al.* 2012; Hettinga *et al.* 2012). Habitat analysis and landscape connectivity modelling have been studied in Manitoba and Saskatchewan (e.g., O'Brien *et al.* 2006; Fall *et al.* 2007; Koper and Manseau 2009; Galpern and Manseau 2013a, b). There has been long-term monitoring of Caribou in the Owl Lake region (Brannen pers. comm. 2014). Manitoba Hydro has collaborated with Manitoba Conservation since 2007 in the collaring and monitoring of Caribou in ranges intersected by a transmission power line project; a radio-collaring study was initiated in 2007 and expanded in 2010 (78 radio-collars) and 2011 (70 radio-collars) (Joro Consultants Inc. 2011). Rettie and Messier (2000) radio-monitored 40 adult female Caribou in the southcentral portion of their range in Saskatchewan and delineated seasonal movements, habitat selection, and assessed vital rates.

In Alberta, vital rates (e.g., adult female survival, calf recruitment, finite rate of population growth, calf:cow ratios) and movement data have been collected from radio-collared Caribou since 2001 (Alberta Caribou Committee). A 4-year research program was initiated which studied relationships between Caribou, Wolf, Moose, and Grizzly Bear (*Ursus arctos*) using GPS collaring and data collection (Decesare *et al.* 2012).

In BC, a Caribou monitoring project was conducted in 2008 and 2009 using radio-telemetry (Thiessen 2009), with further monitoring of 160 collared caribou throughout provincial Boreal Caribou range since 2012 (Culling and Culling 2013).

Since 2002, NT has radio-collared > 180 Boreal Caribou. Vital rates (e.g., adult female survival, calf recruitment, finite rate of population increase) and movement data have been collected from collared Caribou from four different study areas: Gwich'in North, Gwich'in South, South Slave, and Dehcho (Nagy 2011; Kelly and Cox 2001; Nagy *et al.* 2011; Larter and Allaire 2014). Location data from collared female caribou were used to assess demographic and behavioural responses of Caribou to anthropogenic disturbance and to define secure habitat (Nagy 2011).

HABITAT

In this report, habitat is defined as the vegetative structures (e.g., old coniferous forest), as well as factors that influence survival and productivity (e.g., predation levels). The Habitat section is divided into habitat use and habitat avoidance components because avoidance of certain habitats is pronounced in Caribou. There is strong agreement on which factors constitute important habitat to Caribou among ATK and Western science.

Habitat Requirements

Caribou habitat selection is complex; it occurs at multiple spatial and temporal scales, and the avoidance of predation appears to dictate habitat use more than food availability. The emphasis on predation is integral to Caribou management because predator densities increase with anthropogenic and natural disturbances (Bergerud 1974; Vors *et al.* 2007; Wittmer *et al.* 2005; Bastille-Rousseau *et al.* 2012). Separation of proximate from ultimate factors is difficult, and there is variation in behaviour within each DU. Caribou will select small sites to be used for short periods annually (e.g., nursery areas), as well as large areas used for generations (e.g., seasonal ranges), but use of either can shift depending on changing forest conditions. In Manicouagan, Québec, Caribou use of residual patches of old forest stands increased as they became less available (Moreau *et al.* 2012). Selection also varies with spatial scale. For example, nursery areas contained relatively higher abundance of groundcover vegetation, terrestrial lichens, lower shrub density and higher densities of mature confer trees in northern Ontario, when compared to random sites, but at the landscape scale, nursery sites were in remote areas with overall high refuge value from predators and less forage (Lantin *et al.* 2003; Carr *et al.* 2011; Dyke and Manseau 2011; Pinard *et al.* 2012).

Habitat Avoidance

The ultimate factor in Caribou habitat use is predator avoidance, which is achieved by existing at low density, and by avoiding areas with predators, particularly Wolves. A 'stabilizing density' of 0.06 Caribou/km^2 has been suggested as a threshold density wherever Wolf predation is the major mortality factor (Bergerud and Elliot 1986; Bergerud *et al.* 2008). At this density, Caribou can space themselves to balance recruitment and mortality (Schmelzer 2014). BP Caribou in Labrador are typically found at densities of 0.03-0.06 Caribou/km^2 in core areas of their range and 0.004 Caribou/km^2 in peripheral areas (Schmelzer *et al.* 2004; Bergerud *et al.* 2008). The Federal Recovery Strategy estimates an average Boreal Caribou density of 0.02 to 0.03 Caribou/km^2 across BP range (Environment Canada 2012).

Caribou also minimize predation risk by "spatially separating" themselves from predators by using less productive, old forest habitat that does not support sizable Moose or deer (White-tailed [*Odocoileus virginianus*] or Mule [*O. hemionus*]) populations and, consequently, does not support dense predator populations (Bergerud 1974; Rettie and Messier 2000; Racey and Arsenault 2007; Environment Canada 2012; OMNR 2014). At larger spatial scales, Moose, deer, and large predators are more common in areas in

deciduous forest containing large amounts of browse for ungulates (Hall 1984; Peek 2007). By contrast, during snow-free seasons, Caribou use barren lands, alpine tundra, islands in large lakes, and wetlands, all of which are sites that have relatively fewer predators and therefore reduced predation on calves (Mosnier *et al.* 2003; Carr *et al.* 2011; Schaefer and Mahoney 2013). Elders in Tłı̨chǫ (northeast of Ft. Simpson, NT), Little Red Cree River, and Tallcree (both in Alberta) First Nations note that Caribou prefer thick bush, particularly in winter when it is more difficult to remain camouflaged from predators, and that Caribou prefer to be near water in summer in order to access greater abundance of food, cool off, and to avoid insects and Wolves (WRRB 2013; Schramm and Krogman 2001).

Although logged areas and regenerating forest stands can be utilized for foraging in some areas (Hins *et al.* 2009; Hébert and Weladji 2013), Caribou have been found to generally avoid such areas by an average of 1.2 km in Alberta (Smith *et al.* 2000), 4.5 km in Québec (Fortin *et al.* 2013), and 9.2 km in Newfoundland (Schaefer and Mahoney 2007). Miller (2010) quotes Anishinaabe elders as stating that Caribou only enter cut blocks when being chased by Wolves. In Alberta, Caribou daily movement rates and individual winter range sizes decreased in response to timber harvest (Smith *et al.* 2000). Other patterns of habitat use include Caribou only using disturbed sites at nighttime (Beauchesne *et al.* 2013), and use of forest cutovers only when they were adjacent to mature residual stands (Briand *et al.* 2009; Hins *et al.* 2009).

A study in northwestern Ontario using tracks and pellets in winter concluded that Caribou and Wolves were spatially separated, while Moose and Wolves were not (Cumming *et al.* 1996). More recent work using telemetry over a larger area found Wolf territories were smaller in areas with higher Moose density, and Wolves selected habitat types that were selected by Moose (e.g., stands with deciduous or regenerating forest) and avoided some habitat types (e.g., dense conifer) that are selected by Caribou (Anderson 2012; Shuter pers. comm.). In a disturbed landscape in Alberta, Peters *et al.* (2013) reported a significant positive relationship between spatial overlap of Moose and Caribou, and the degree of human landscape alteration. They found that locations of Caribou mortalities corresponded with areas of high resource use by Moose in summer, suggesting that early successional forest stages may decrease spatial separation between Caribou and Moose, resulting in increased predation risk for Caribou. Traditional knowledge indicates that industry within BP habitat diminishes this spatial separation and alters predation rates on Caribou (Dehcho First Nations 2011, cited in COSEWIC 2012).

Forestry operations can directly remove lichen biomass available to Caribou (Fisher and Wilkinson 2005) but the limited use of recently disturbed sites likely is related mainly to predator avoidance. The abundance of forage within disturbed habitats can be attractive to Caribou and make them more prone to predation (Beauchesne *et al.* 2014) because Black Bears (*Ursus americanus*), Wolves, and Coyotes (*Canis latrans*) frequent cutovers (James *et al.* 2004; Kays *et al.* 2008; Mahoney and Virgl 2003; Mosnier *et al.* 2008b; Boisjoly *et al.* 2010; Bowman *et al.* 2010). Moose and deer populations thrive in disturbed areas and support larger Wolf populations than would be present if Caribou were the primary prey species (Bergerud and Elliott 1986; James *et al.* 2004; Latham *et al.* 2011b). In the Charlevoix sub-population in Québec, regenerating stands (6-20 years old) had the

greatest ground vegetation cover, providing a high biomass of berries and other vegetation for Black Bear (Brodeur *et al.* 2008). Mosnier *et al.* (2008b) reported similar positive effects of logging on the Black Bear habitat in the GP range. Caribou selected forest habitat that provided seclusion from Black Bears and Wolves. Pinard *et al.* (2012) and Dussault *et al.* (2012) reported that variation in habitat selection tactics among females with calves resulted in different Black Bear predation risks for their calves. Recruitment rate is inversely linked to the proportion of early seral stage forest stands in managed landscapes (Environment Canada 2008).

In the NT and northern Alberta, Caribou avoided linear features such as seismic lines by 400 m (Nagy 2011). Travel rates were inversely related to seismic line densities; local Caribou movements may have become increasingly constrained as seismic line densities increased, and Caribou avoided seismic lines during periods when they were vulnerable to predation and/or harvest. In Alberta, Dyer *et al.* (2001) reported that female Caribou avoided areas within 1 km of well sites, and avoided areas within 250 m of roads and seismic lines. This avoidance behaviour was more pronounced in winter and lowest in summer. Wasser *et al.* (2011) reported that during winter, Caribou in northeastern Alberta did not avoid unused secondary linear features, but did avoid primary roads. Near Lake Nipigon, Cumming and Hyer (1998) recorded avoidance of a log haul road in use by 25 trucks working 24 hours/day, but not in the year before and after the road was active, suggesting the traffic was a concern and not the road. In Québec, Caribou strongly avoided road networks by at least 2 km (Rudolph *et al.* 2012; Dussault *et al.* 2012), and up to 10 km (Rudolph 2011). Tertiary forest roads are avoided by 750 m, primary roads by 1.25 km, and highways by 5 km (Leblond *et al.* 2011, 2013a). These metrics are comparable to a 4 km threshold of road avoidance in Ontario (Vors *et al.*'s 2007), and a 4.5 km avoidance in Québec (Fortin *et al.* 2013). Leblond *et al.* (2013a) estimated a zone of influence (ZOI) of 5 km from roads and reported that within this ZOI, Caribou avoided habitat types that were otherwise selected at the home range scale, and displayed higher movement rates, especially when traffic density was high.

The avoidance of linear features appears to be related to predation risk. Seismic lines (McLoughlin *et al.* 2003; Latham *et al.* 2011a) and roads (Whittington *et al.* 2011) may be used by Wolves as travel routes (which facilitate access into once-secluded Caribou habitat), can provide barriers to Caribou movement (Dyer *et al.* 2002), and change encounter rates between Caribou and their predators. In the NT, predation mortalities were closer to linear features (Larter and Allaire 2014) than locations of live Caribou (James and Stuart-Smith 2000). Computer simulations suggested that Wolf-Caribou encounters increased with the density of linear disturbances in Caribou habitat (McCutchen 2006; Whittington *et al.* 2011).

Anthropogenic disturbances cause direct loss of Caribou habitat through range modification. Noise pollution from trucks and other industrial activity may drive Caribou away from areas actively used by humans (COSEWIC 2012). Female Caribou establish nursery areas in areas with lower levels of sensory disturbance from development or recreational activities (Carr *et al.* 2007; Schaefer and Mahoney 2007; Vors *et al.* 2007; Vistnes and Nellemann 2008). A critical threshold of 10-15 km from disturbance was recommended for parturient Caribou (Carr *et al.* 2011). Caribou may also experience chronic stress and negative energetic consequences when fleeing disturbances (Bradshaw *et al.* 1998). Individuals have been found to become confined into smaller, less productive habitats if disturbance is severe (Beauchesne *et al.* 2014). Caribou often show diminished use of areas within a 1-10 km radius of these disturbed landscapes (Duchesne *et al.* 2000, Mahoney and Schaefer 2002a; Cameron *et al.* 2005; Vors *et al.* 2007; Weir *et al.* 2007; Hins *et al.* 2009; Faille *et al.* 2010; Mahant 2013).

The probability of remaining and surviving in an area decreases with the quantity and severity of the disturbance (Vors *et al.* 2007, Environment Canada 2011). Lesmerises *et al.* (2013) reported that in landscapes with small patches (<100 km^2) of habitat, Caribou became concentrated, which increased their vulnerability to predation and acted as ecological traps. To increase the likelihood of Caribou occurrence, they found that core forests must be greater than 1000 km^2 in size and not surrounded by a dense network of roads, cutovers, and cabin developments.

Habitat Use

Selection for rich lichen feeding areas, particularly during winter when lichen may be the only forage available, can be an important driver of Caribou distribution within the boreal forest (Mayor *et al.* 2009). In Ontario, 'Winter Use Areas' are associated with soil and forest cover conditions that provide abundant ground lichen (*Cladina* and *Cladonia* species) (OMNR 2014). Ground lichens are low in protein but are an important winter source of carbohydrates (Schaefer and Pruitt 1991). Caribou may dig through snow to access terrestrial lichens, or forage on arboreal lichens that grow on old trees. Mature and old coniferous forests generally have shallower snow and less crust compared to open areas and are thus used for access to lichens, and as shelter from harsh winter conditions (Mosnier *et al.* 2003; Ferguson and Elkie 2004; Mayor *et al.* 2009).

Mature and old coniferous forests are generally recognized as important habitats for Caribou and are utilized throughout the year (Festa-Bianchet *et al.* 2011; Bastille-Rousseau *et al.* 2012). It is difficult to assess how old a stand should be to provide adequate habitat to Caribou but research in Ontario suggests that Caribou will use natural stands aged ≥ 50-60 years (Elkie *et al.* 2009). In the Assinica region (Québec), Caribou occur in areas with a fire cycle of 67 years (Girard pers. comm. 2014). Caribou demonstrate habitat selection in response to the natural heterogeneity of the boreal forest (e.g., tree age and species composition) (Racey and Arsenault 2007). For example, Caribou will use smaller, discrete patches of young forest and hardwood forest, provided these sites are near larger patches of conifer-dominated forest (Elder pers. comm.).

The size of forest stands also is important. Lesmerises *et al.* (2013) demonstrated in Québec that forest stand size must reach approximately 270 km^2 to attain a 50% probability of use by Caribou. They concluded that a range composed of stand sizes from 100 to 250 km^2 is too small to support BP Caribou, and that the matrix composition and structure of the forest is important. Nagy (2011) hypothesized that Caribou in the NT can be sustained in areas where ≥46% of the land is unburned habitat found in patches >500 km^2 in a relatively pristine range, and with low predator and alternate prey diversity. These habitat components may be important for a number of activities, including foraging, calving, and insect relief, or simply to provide connectivity among preferred habitats (Nagy 2011).

Newfoundland population

The habitats available to the NP are composed of a mosaic of small to extensive patches of coniferous forests, barren lands, shrub lands, and bog/wetland complexes. Winter snow conditions strongly influenced Caribou habitat selection in the central portion of the island, and coniferous forests were important habitats all year (Hébert 2012). Wetlands, barren lands, and shrub lands are generally preferred during snow-free seasons, and mature-old coniferous forests are used in winter to minimize energetic stress related to snow accumulation (Mahoney and Virgl 2003; Wells *et al.* 2011). Females tend to migrate and aggregate at traditional calving grounds, characterized as barrens surrounded by contiguous coniferous forests and broken by areas of wind-scarred trees or old coniferous stands, from April to mid-May (Saunders 2007). Females of the Middle Ridge sub-population have a stronger preference for bogs than do males, which may serve to reduce calf predation risk (Schaefer and Mahoney 2007). In winter, female Caribou of the same sub-population selected high terrestrial lichen abundance at a broad scale and, within lichen-rich areas, selected microsites with soft and shallow snow (Mayor *et al.* 2007, 2009).

Fecal samples from 1990-1997 and 2010-2011 showed that NP consume a wide variety of plants throughout the year, with terrestrial lichens being a large portion (33% in summer, and 62% in autumn) and arboreal lichens being relatively rare in NP diet (< 4%) (Soulliere and Mahoney 2014). Despite this use, terrestrial lichens are not thought to be a limiting food resource in Newfoundland (Humber *et al.* 2009).

While some of the sub-populations occupy relatively undisturbed landscapes, others occupy areas disturbed by industrial forestry, access development, and other anthropogenic footprints. Some sub-populations avoid recently harvested areas, and females with calves displayed heightened sensitivity (Chubbs *et al.* 1993; Mahoney and Virgl 2003; Schaefer and Mahoney 2007). Areas with timber harvesting were associated with reduced calf recruitment rates for NP Caribou (McCarthy *et al.* 2011).

Gaspésie population

The GP extensively use alpine habitat on mountain plateaus and mature Balsam Fir (*Abies balsamea*) and spruce stands on forested mountain slopes at >700 m asl (St-Laurent *et al.* 2009). Alpine habitats are sometimes abandoned when snow conditions impede access to forage (Ouellet *et al.* 1996). During summer, GP often use high altitude areas where stronger winds and remnant snow patches provide relief from insect harassment (Boileau 1996). Caribou also congregate on open habitats at high elevations during rut, which facilitates mate access (Bergerud 1973; Ouellet *et al.* 1996). In the spring, females with calves remain at high elevations consuming winter forage despite availability of new green forage at lower elevations; this may reduce risk of calf predation (Ouellet *et al.* 1996).

During winter, the GP may seek mature Fir stands to access other winter forage, such as arboreal lichens (Boileau 1996; Mosnier *et al.* 2003), which can comprise up to 53% of GP winter's diet (27% in summer, St-Laurent *et al.* 2009). Arseneau *et al.* (1997) estimated the arboreal lichen biomass (primarily *Usnea* spp., *Alectoria sarmentosa*, and *Bryoria* spp.) in the GP range in three altitudinal belts ranging from 720 to 1068 m, and reported biomasses of 1306, 150 and 11 kg/ha for the mountain (<900 m), subalpine and alpine (>1000 m) belts, respectively. Within the coniferous forest, dense snowpack can facilitate Caribou access to higher arboreal lichens, thereby increasing forage availability. Mosnier *et al.* (2003) found that GP selected forest patches that had more arboreal lichen, larger trees, and harder snowpack. Terrestrial lichens are relatively absent in GP range and are rarely consumed (St-Laurent pers. comm.).

Boreal population

Local variations in habitat selection occur within ecozones (Environment Canada 2011), but BP habitat consists chiefly of mature or old forest (*i.e.*, >80 years old) spruce (*Picea* spp.) and pine (*Pinus* spp.) stands intermixed with peatlands and muskegs, with abundant lichens and low predator densities (O'Brien *et al.* 2006; Brown *et al.* 2007; Courtois *et al.* 2007). In northeastern BC, Caribou primarily use large peatlands throughout the year, and closed-canopy mature Lodgepole Pine (*Pinus contorta*) and Black Spruce (*Picea mariana*) stands during late winter and periods of high snow accumulation (BC Ministry of the Environment 2010). In Ontario and Québec, females used habitats which are composed primarily of mature or old coniferous forest (Brown *et al.* 2003; Courbin *et al.* 2009). The BP caribou generally do not use recent burns, perhaps due to low lichen availability (Rettie and Messier 2000; Vors *et al.* 2007; Sorensen *et al.* 2008). In BC, recent burns were used during the spring for access to non-lichen forage (Boonstra and Sinclair, cited in Fisher and Wilkenson 2005). BP wintering locations vary little from year to year (Cumming *et al.* 1996; Ferguson and Elkie 2004), and typically consist of lichen-rich ranges characterized by shallow snow (Barrette and Vandal 1986; Courbin *et al.* 2009; Moreau *et al.* 2012). Site fidelity decreased in areas disturbed by natural or anthropogenic events (Faille *et al.* 2010).

Habitat Trends

The section below outlines trends in habitat that have occurred recently and typically are ongoing. The **Threats** section of the report outlines present threats, many of which relate to change in habitat, but also predictions of the future change in habitat.

A) Change in Structural Habitat

The response of Caribou to forestry seems to be similar across the species' range, likely because clear-cut harvest is common within the range of each DU. An important aspect of forestry is the temporal nature of the threat. Widespread re-occupancy of clear-cut sites has not been documented (Wilkinson 2010) but succession in disturbed forests will result in increased food and cover over time, suggesting Caribou should reoccupy clear-cut harvested sites. Some Caribou recovery plans and forest management plans rely on harvested areas to eventually become Caribou habitat (see **Habitat Protection and Ownership** section). In Ontario, for example, three logged sites clear-cut between 1952 and 1970 were replanted with pine or spruce and are now used by Boreal Caribou in both summer and winter, a finding in large part attributed to the refuge habitats that remained in the vicinity (Racey *et al.* 1996; Racey *et al.* 2010; Rose and Racey 2010; OMNR 2012). Reoccupation of cutovers can occur if the cutovers regain characteristics similar to the original stand (Fisher and Wilkinson 2005; Faille *et al.* 2010) but not all cutovers return to similar condition; Hébert and Weladji (2013) showed cutovers (>40 years) did not develop into forests with similar stand characteristics as the coniferous forests selected by Caribou in central Newfoundland. The regenerated canopy in the cutover sites was more closed, and supported less forage, than the uncut coniferous forests.

Reoccupancy may also be influenced by predation, at least in the BP. Caribou may be absent from older cuts if Wolf and Moose densities remain higher (Boertje *et al.* 1996; Rettie and Messier 2000), and lichen availability is lower (Johnson *et al.* 2004). Vors *et al.* (2007) reported that the Caribou inhabiting areas within 13 km of clear-cuts in Ontario became extirpated within 20 years. Faille *et al.* (2010) showed that Caribou displayed high fidelity to logged areas, which created an ecological trap of increased predation. Vors *et al.* (2007) reported that Caribou were extirpated within 20 years from areas within 13 km of clear-cuts. In summary, reoccupancy is difficult to predict, and given the multiple scales and factors related to occupancy by Caribou, it is likely that use of any particular harvested area is associated with the amount and configuration of forest at larger scales that retained Caribou, as well as predator densities.

Newfoundland population

Habitat use by the NP changed when the decline began after the 1990s. A study reviewing 30 years of habitat selection data of one NP sub-population (*i.e.* Middle Ridge) found that Caribou shifted their habitat preferences by avoiding cutovers as well as open and closed forests, and instead selecting barrens, shrubs and wetlands (Mahoney and Schaefer 2011). The changes in habitat use may be indicative of a response to predators, but also limited lichen abundance. The portion of moss in NP diets has increased since the

1990s and Horsetail (*Equisetum* sp.) did not appear in their diet until the 2010s. Increased tooth wear may have resulted from an overall decrease in diet quality, or may be related specifically to high silica content in horsetails. Preliminary analyses indicate reduced range quality since the peak of the NP (Soulliere and Mahoney 2014). Caribou are exhibiting density-dependent morphological responses, such as decreases in jaw bone size, birth weight, and antler quality, which are characteristic of low nutrient availability (Mahoney and Weir 2009; Mahoney *et al.* 2011; Weir *et al.* 2014). Some of these indices are returning to pre-decline levels (see **Fluctuations and Trends** section).

Caribou habitat may be adversely affected by the high density of introduced Moose. An overall density of approximately 1.3 Moose/km^2 and a maximum density of approximately 15 Moose/km^2 in local areas are some of the highest densities in the world (McLaren *et al.* 2004). High densities of Moose negatively affect the capacity of Balsam Fir to regenerate following canopy disturbance (Gosse *et al.* 2011). Overabundant Moose on the island are affecting the landscape by slowing the succession rate of the forest after a disturbance, which can influence Caribou habitat over the long term. However, at present there is no conclusive evidence that Moose are strongly impacting NP Caribou.

Gaspésie population

At the beginning of the 20th century, the pre-industrial forest of the Gaspésie region consisted primarily of >100-year-old stands of Balsam Fir and White Spruce (*Picea glauca*). Extensive forestry activity over the past 50-70 years changed mature forest structure into young forests (Lesmerises 2012) and the new forest generally did not retain all attributes of the natural ecosystem. For example, Boucher *et al.* (2009) concluded that 20th century logging practices strongly altered the eastern Québec region's pre-industrial vegetation patterns to the point that ecosystem-based forest management strategies should be developed to restore conifer dominance, altitudinal gradients, as well as the irregular structure similar to old forest stands.

In the GP range, Stone *et al.* (2008) reported that arboreal lichen biomass increased slowly through time, with negligible biomass production <50 years and greatest biomass at 70-90 years in the Balsam Fir-dominated stands. They suggested that lichen biomass will plateau at the same time that trees are senescing, which is about 100 years.

Forestry within Gaspésie National Park was permitted from 1938-1977 and mining was conducted between 1943 and 1963 (St-Laurent *et al.* 2009). Natural resource exploitation continues within the Chic-Chocs Wildlife Reserve and Matane Wildlife Reserve, which are contiguous to Gaspésie National Park. Consequently, much of the surrounding habitat for GP is continually impacted by resource development. The disturbed landscape maintains high predator abundance, primarily of Black Bear and Coyote (St-Laurent *et al.* 2009).

The GP co-occurs with a high Moose population. In 2007, Moose density was estimated at 4.8 Moose/km^2 in the Matane Wildlife Reserve (Lamoureux *et al.* 2007), a Moose density never reached before in Québec and which negatively affected regeneration of Balsam Fir following forest harvest (Gingras 2013). Moose may have a detrimental impact on the GP habitat via high levels of grazing, but also the transmission of parasites (see Threats – Problematic Native Species section).

Habitat use by female Caribou, particularly those with calves, has changed over recent decades. GP are not showing seasonal differences in habitat use; they remain on mountain summits during the spring, where the likelihood of predator encounters is low, predator detection is high, but nutritious forage is scarce (Ouellet *et al.* 1996). The GP have demonstrated increasing use of open habitats since the 1970s. Ouellet *et al.* (1996) reported that 31% of the radio-locations were found in alpine habitat between 1975 and 1977, compared with 45% between 1987 and 1992. During 1987-1992, 43% of summer and 62% of autumn locations were in alpine habitat (Ouellet *et al.* 1996), compared to 65% (summer) and 70% (autumn) of locations from 1998 to 2001 (Mosnier *et al.* 2003). Increased use of alpine habitat could be an anti-predator strategy but changes in snow conditions, disturbances in areas located outside the park, avoidance of linear features within the park, or changes in interspecific competition may also explain these changes in habitat use. Escaping toward higher ground may also be a parasite avoidance strategy to space out from Moose and White-tailed Deer that may carry Meningeal Brainworm (Kutz pers. comm.).

Boreal population

Forestry, roads, utility corridors, petroleum infrastructure, multi-use trails, and mining all have been recorded as having negative impacts on BP habitat (e.g., James and Stuart-Smith 2000; Rettie and Messier 2000; Dyer *et al.* 2001; 2002, McLoughlin *et al.* 2003; Vors *et al.* 2007; Arsenault and Manseau 2011; Latham *et al.* 2011a; Dussault *et al.* 2012; see **Threats** section). Disturbed habitat is defined in the National Recovery Strategy (Environment Canada 2012) as habitat showing: i) anthropogenic disturbance visible on Landsat at a scale of 1:50,000, including habitat within a 500 m buffer of the anthropogenic disturbance; and/or ii) fire disturbance in the last 40 years, as identified in data from each provincial and territorial jurisdiction (without buffer) (Environment Canada 2012). The greatest industrial disturbance footprint in BP range occurs in the southern boreal regions across Canada (Figure 3). In Alberta, all BP ranges are highly disturbed (range: 57-95%, Environment Canada 2012). In BC, Thiessen (2009) reported high disturbance levels (range: 58-87%) caused especially by oil and gas development. Less is known about Caribou in Saskatchewan, and in some regions of Manitoba and Ontario (Environment Canada 2012). In the NT, the BP range is less disturbed (31%), and most disturbance (24%) is caused by fires (Environment Canada 2012). At least half of BP range across northern Ontario, Québec, and Labrador remains relatively undisturbed from anthropogenic sources. Figure 3 illustrates a typical spatial pattern of anthropogenic disturbance in the southern Caribou range, and natural disturbance from fire and blowdown in northern parts. In eastern Canada, the BP range is receding northward, while in western provinces, it is becoming highly fragmented and receding northward.

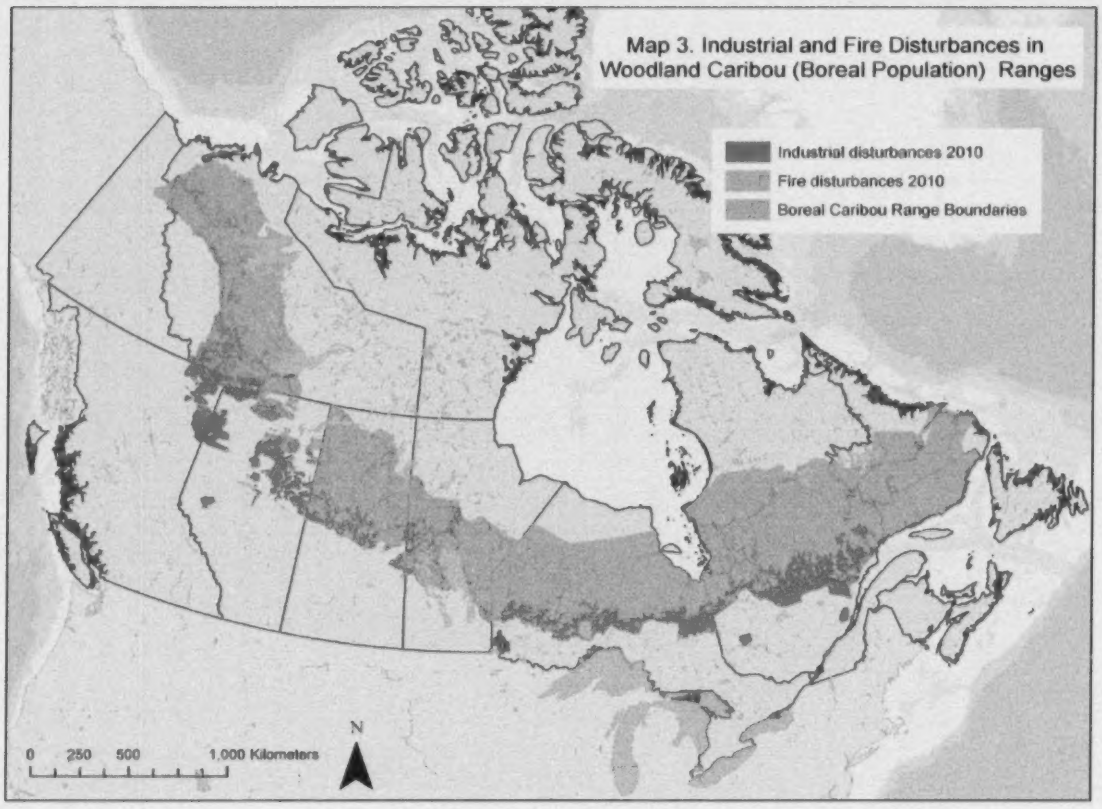
Map 3. Industrial and Fire Disturbances in Woodland Caribou (Boreal Population) Ranges
Industrial disturbances 2010
Fire disturbances 2010
Boreal Caribou Range Boundaries
N
0 250 500 1,000 Kilometers

Figure 3. Location of anthropogenic (e.g., forest harvest, mining, roads, with 500m buffers) and natural (e.g., fire, blowdown) disturbance in remaining Boreal population designatable unit, as of 2010. Source: Lee (2012).

B) Change in Predation Rates

Predation rates can increase to unsustainable levels when changes in forest habitat increase Moose or White-tailed Deer populations, or new predators arrive. Predation rates on Caribou can increase after land use change (e.g., roads, forestry) because of increased access (see **Threats** section) but also because of increased predator densities due to the arrival of alternative prey. The term 'apparent competition' describes population decline of one prey species concurrent with population increase of another prey species, not because of direct competition for a shared food resource, but because of a shared predator (Holt 1977). Apparent competition begins when natural and/or anthropogenic disturbances alter forest structure into ideal habitats for Moose and deer (Latham *et al.* 2011b). In turn, these ungulates support higher predator populations than would Caribou alone, given their younger age at first reproduction and multiple births, and Caribou suffer more from predation impact. Typically, the novel prey species (*i.e.*, Moose or deer) is a habitat

generalist with high reproductive output, and predator numbers do not respond numerically to declines of the original prey species (*i.e.*, Caribou) (Holt 1977). The resultant inverse density-dependent relationship between predator and original prey can result in local extirpation of Caribou, or may suppress it well below carrying capacity.

There are alternative hypotheses from apparent competition for Caribou declines. It is possible that predation rates have increased because linear features, such as roads, seismic lines, and hydro corridors have increased the efficiency of predator foraging. It is also possible that Caribou populations are more vulnerable to predation because Boreal Caribou are being confined to a restricted number of undisturbed areas (Elder pers. comm.). Research is underway in Ontario to assess these hypotheses, as well as identify potential additive and interacting factors in Caribou declines (OMNR 2014).

Newfoundland population

Predation accounted for 59% of calf deaths from 1979-1997 (Mahoney and Weir 2009), and 90% between 2003 and 2012 (Lewis and Mahoney 2014). The role of apparent competition is unknown in the NP but it is not considered to be as significant as it is in the other DUs. It is unknown whether forest harvest has increased Moose populations in NF, and secondly whether predator density has increased because of Moose. There is evidence that Coyote and Black Bear consume a great deal of Moose meat, primarily as carrion. However, it is not clear if Moose carrion has an influence on population levels of Coyote and Bear (Pardy Moores pers. comm.; ENVC unpubl. data).

Our understanding of the impact of apparent competition is based mainly in areas where Wolves are the primary predator on Caribou, but Wolves are absent from the NP and Coyote do not appear to be depredating large numbers of adult Caribou. Of 730 neonate calves radio-tagged from 2003-2012, 57% died from predation within 6 months (Lewis and Mahoney 2014). Most (90%) of mortalities were due to predation. Cause of death was Black Bear (34%), Coyote (28%), Bald Eagle or Lynx (16%), predator not determined (16%), and remaining due to starvation, accident, or orphaning. Coyotes reached Newfoundland in 1985 (Mahoney and Schaefer 2002b). Lynx were historically a main predator of calves (Bergerud 1971) but are less so with the arrival of Coyote; it is possible that Coyote depredation is compensatory to Lynx depredation. There is little evidence that Coyote are significant predators of adults in winter, with only 18 of 424 radio-collared adults killed by Coyote between 2004-2011(Lewis and Mahoney 2014). Adult survival rates pre- and post-Coyote colonization are not significantly different, suggesting that Coyote predation is not additive to other causes of adult mortality (Weir *et al.* 2014).

Gaspésie population

Wolves were extirpated from the region by 20th century and the smaller Coyote was established in the 1980s (Crête and Desrosiers 1995). Although Coyotes are smaller than Wolves, Coyote predation on GP Caribou is significant enough to affect population abundance, and Coyotes are increasing with disturbance (see **Threats** – Problematic Native Species section).

Boreal population

Apparent competition is considered a primary contributor to the decline of Caribou in parts of BP range (Stuart-Smith *et al.* 1997; Rettie and Messier 1998; Schaefer *et al.* 1999; Vors *et al.* 2007). Apparent competition in Wolf-Caribou-Moose systems is well studied in western Canada, but less so in eastern Canada.

Wolves are considered the primary predator of Caribou in the BP range (Rettie and Messier 2000; McLoughlin *et al.* 2003; Wittmer *et al.* 2005). Wolves may actively seek the less competitive prey species (e.g., Caribou) (Tremblay-Gendron 2012) while Black Bears are more opportunistic predators (Bastille-Rousseau *et al.* 2011). Wolves are predicted to cause population decline in Caribou population if their density is > 6.5 wolves/1000km^2 (Bergerud and Elliot 1998).

Caribou persistence in the boreal forest will depend on whether their space needs for predator avoidance are met (Bergerud 1985, 1988). Smith *et al.* (2000) reported that if fragmentation of Caribou winter range in Alberta continued via timber harvesting and other industrial activities, the "spacing out" anti-predator strategy used by Caribou may be compromised.

In parts of the BP range in Alberta, Wolf densities have increased from 6 wolves/1000km^2 in 1994-1997 (James *et al.* 2004) to 11.5 wolves/1000km^2 in 2001-2009. Caribou declines accelerated during higher Wolf density (Hervieux *et al.* 2013). Changes in Wolf density in other parts of the range are not available.

No published studies on Caribou reoccupying disturbed areas that contain high predator and alternative prey populations are known. Apparent competition may irrevocably compromise the ability of Caribou to spatially separate themselves from predators and alternative prey (Losier 2013; Peters *et al.* 2013).

BIOLOGY

Life Cycle and Reproduction

Maximum recorded longevity is 22 years in captivity (Müller *et al.* 2010) and estimates of 19.5 (Schmelzer pers. comm.) and 17 (Larter and Allaire 2014) years have been made for wild BP Caribou, but few males and females exceed 10 years and 15 years, respectively (Thomas and Kiliaan 1998; Larter and Allaire 2014). Age structure within a Caribou population may change over time because survival and fertility rates within each age class change over time. For example, the average age of females in NP was 3.8 years in 1980, and 6.2 years in 2008 (Lewis and Mahoney 2014). Generation length in this report is based on the average age of parents within the population and therefore reflects the turnover rate of breeding individuals in a population (IUCN Standards and Petitions Subcommittee 2013). For the NP, average survival and fertility rates for 2004 and 2010 were 0.86 and 0.77,

respectively. Generation length was estimated at 6.2 years for the NP, assuming that senescence starts at 12 years for survival and 9 years for fertility, and maximum life span is 17 years (Neville, J., NLDEC, unpubl. data 2013). A generation length of 6 years is used in this report. Generation lengths are not calculated for the GP and BP but are likely to be similar to the 6 years.

Caribou populations are usually female-biased, possibly due to preferential sport hunting of males in some areas. Bergerud (1980) reported a mean sex ratio among adults of 36 males per 100 females for the GP, 32 for 'interior sub-populations' in NP, 40 for the NP Avalon sub-population, and 40 for the BP Pukaskwa sub-population in Ontario. Hettinga *et al.* (2012) estimated a sex ratio of 76 males:100 females for Manitoba's North Interlake BP sub-population. In NP, adult sex ratio has become increasingly female-biased since the 1960s (Mahoney and Weir 2009; Weir *et al.* 2014). Harvest rate of males was estimated at 16% during the 2000s. The proportion of males in the population has been increasing since 2009 with the adoption of 'either sex' licences, which reduced hunting pressure on males (NLDEC, unpubl. data 2013). In the non-hunted GP, sex ratio has been near equal since 1983 (Lalonde pers. comm. 2014).

Females first produce young between 24-48 months, depending on quality of range (Bergerud 1971; Crête *et al.* 1996; Larter pers. comm.). Male Caribou can be sexually active at 2 years, but usually > 4 years of age. In the NT, BP female Caribou have produced calves between 2-16 years of age (Larter and Allaire 2014). Caribou give birth to a single offspring. Parturition is highly synchronized within a Caribou population but varies geographically; for example, parturition peaked in mid-May in BC (BP) (BC Ministry of Environment 2010), mid-late May in NT (BP) (Nagy 2011; Larter and Allaire 2014), end of May in Newfoundland (NP) (Bergerud 1975), and early to mid-June in Labrador (BP) (Schmelzer 2014).

Caribou are polygynous; males gather females into harems, though not as pronounced as in other gregarious ungulates, and tend to guard several females at a time and prevent other males from approaching (Kelsall 1968; L'Italien *et al.* 2012). The rutting period for the NP was mid-October (Bergerud 1975) and late September to mid-October in the BP Labrador range (Schmelzer 2014). In the GP, the rutting period was first three weeks of October (Bergerud 1973).

Gestation length for Caribou is 215-230 days (McEwan and Whitehead 1972; Bergerud 1975). Females may conceive in alternate years when foraging conditions are poor, or a female's body fat and protein reserves are diminished from rearing previous offspring (Gerhart *et al.* 1997). Pregnancy and productivity rates are usually high (75-100%) within the BP (Bergerud 1974; Nagy 2011; Rettie and Messier 1998). In the NP, productivity ranged from 70-100% from 1960 to 2012, with most years falling between 70-90% (Weir *et al.* 2014). Productivity in the NP has displayed minor variability, especially when compared to other life history parameters (e.g., abundance, mean age, calf survival, etc.). Pregnancy rates for the GP ranged between 60% (in 2013) and 89% (in 2014) (M.-H. St-Laurent, unpubl. data).

Physiology and Adaptability

Caribou often experience marked seasonal fluctuations in body fat and protein reserves, which reflect differences in forage quality and energetic stressors (e.g., deep snow, insect harassment) (Barboza *et al.* 2004; Barboza and Parker 2008; Vors 2013). During the snow-free season, Caribou consume a wide variety of nitrogen-rich herbaceous vegetation, which is essential for protein synthesis. Male Caribou may lose up to 25% of their protein reserves during the rut (Barboza *et al.* 2004) and female protein stores are allocated to gestation and lactation (Gerhart *et al.* 1997). Caribou winter diet is nitrogen-poor because of higher dependence on lichens, but Caribou are able to conserve protein to cope with this dietary deficiency (Parker *et al.* 2005). Caribou also reduce forage intake during winter in response to reduced forage quality and availability (*i.e.*, under the snow), as well as to lower energy requirements.

Dispersal and Migration

Newfoundland population

The NP aggregate into social groups of tens to hundreds of individuals, and most sub-populations undertake small seasonal migrations. Some NP sub-populations undertake short seasonal migrations to calving grounds, and summer and wintering ranges, while other sub-populations remain within the same general area throughout the year. The timing of NP migration varies within and between sub-populations and may even vary on an individual scale due to environmental factors (e.g., snow), or may be consistent from year to year, regardless of environmental factors (Mahoney and Schaefer 2002a).

Seven migratory corridors are consistently used by the NP (Wells *et al.* 2011). Caribou remain at calving grounds until late June before migrating to summer ranges. Site fidelity is strong but varies with season and density (Weir *et al.* 2014). Aggregation is most pronounced during post-calving (Schaefer and Mahoney 2013). NP display less movement and stronger site fidelity during summer, and possess less fidelity to traditional calving grounds following a population peak (Schaefer and Mahoney 2013). Following the rutting season, Caribou migrate to wintering areas with better access to forage and cover. In contrast, females exhibit much weaker philopatry during winter and individuals were typically 35-45 km away from their previous year's location (Schaefer and Mahoney 2013). This pattern may indicate that the NP is more flexible about foraging conditions (e.g., abundance and availability) in winter than in spring and summer because they may face more stringent habitat requirements during these seasons.

Gaspésie population

The GP undertakes altitudinal migrations on a limited spatial scale, from closed coniferous forest to open alpine sites (Moisan 1958). The home range size of adult females is small (mean 148 km^2, from 1987-1992) and does not vary seasonally or annually (Ouellet *et al.* 1996). The GP use alpine habitats in the fall, as open areas seem to facilitate mate interactions (Bergerud 1973). Females use alpine habitat in spring and at calving to avoid predation. Nevertheless, no distinct seasonal migration pattern exists for females (Ouellet *et al.* 1996).

Dispersal is limited for the GP because habitat around their annual range has been highly modified by forestry. It appears that Caribou on the three summits (Logan, Albert and McGerrigle; Figure 2) are relatively isolated and that the DU is acting as a metapopulation composed of three sub-populations. The Mount Logan sub-population was previously abandoned by Caribou in the 1980s and later recolonized starting in 1997, likely by Caribou that dispersed from Mount Albert (Fournier and Faubert 2001; Mosnier *et al.* 2003). Movement is limited though; there have not been any observations of movement from one summit to another during telemetry surveys (1975-1977; 1987-1992, 1998-2001), or when nearly half (45%) of the population have been collared (2013-present). As well, resource selection modelling suggests that the matrix between the summits is a functional barrier and movement is not expected to be significant (Gaudry 2013). There have been cases of solitary Caribou, mostly males, moving approximately 200 km away, up to the Matapédia Valley in the southwest, and to the tip of the Gaspésie Peninsula to the northeast (St-Laurent pers. comm. 2014).

Boreal population

BP Caribou group size is typically < 50 animals, with the smallest number occurring during calving when females disperse, and the largest number during the rut and winter (Bergerud 1985). For example, in BC, mean group size was 6 Caribou in October and March, but females in the same range were by themselves (or with newborn) during calving (BC Ministry of Environment 2010).

Caribou in the BP frequently move over large areas to access predator-free areas, and food. Changes in movement patterns and behaviour suggest that there are 4-6 distinct seasons; a summer calving and post-calving season, a late winter season where Caribou were more sedentary, and spring and early winter seasons where Caribou made much larger and directional movements (Brown *et al.* 2003; Ferguson and Elkie 2004; OMNR 2014). Rudolph and Drapeau (2012) suggest there are three seasons; winter, spring dispersal, and calving.

Annual home range size varies greatly across the range (Rasiulis *et al.* 2012). Home range size for female Caribou ranged from 3312-4790 km^2 in northeastern Ontario (Brown *et al.* 2003). Caribou home range varied from 1148 km^2-5000 km^2 and average movement was 37-53 km between winter and summer range in the Ontario Shield Ecozone, while those in the James Bay Ecozone had home ranges of 15000-75000 km^2, and moved up to

384 km between summer and winter ranges (OMNR 2014). Mean annual home range size ranged from 776-2796 km^2 among four local populations in Québec (Bastille-Rousseau *et al.* 2012). Of these populations, the northernmost Jamésie population displayed the largest home ranges. In Labrador, average home range size was 5650 +/- 259 km^2 for the Red Wine Mountain sub-population, compared to 4866 ± 256 km^2 for the Lac Joseph sub-population, monitored for 4-11 years (Rasiulis *et al.* 2012). Larter and Allaire (2014) reported that the mean home range size for 82 female Caribou was 2989 km^2 (range 261-14,420 km^2; median 2328 km^2) in the NT.

The annual movements of Caribou consist of small-scale shifts between seasonal ranges that are embedded in a larger annual home range (Brown *et al.* 2003). Rasiulis *et al.* (2012) reported on the importance of long-term monitoring because monitoring lasting ≤ 3 years captured < 65% of the sub-population range for Caribou in Labrador. They also demonstrated that range size increased with each additional year of monitoring, for up to seven years. Home range sizes for individual BP in Labrador indicate that animals increase their range over time and make use of large regions (~5000 km^2) throughout their lifetime, a strategy consistent with a long-lived animal at low densities in a landscape with varying environmental conditions (Schmelzer 2014).

Although some areas have recorded low site fidelity (e.g. in Saskatchewan; Rettie and Messier 2001), most studies indicate site fidelity is strong in BP, particularly by females to calving grounds (Schaefer *et al.* 2000; Faille *et al.* 2010; BC Ministry of the Environment 2010; Shuter and Rogers 2012). For example, in the Mealy Mountain sub-population, Labrador, site fidelity to calving grounds was strong among 12 females that calved an average 3.9 km (year 1) and 11.5 km (year 2) from sites used the previous year. Lower snow levels in year 2 may explain lower fidelity. Post-calving fidelity averaged 7.7 km, and winter fidelity was weakest, at 17 and 19 km (Popp *et al.* 2011). Females in BC made pre-calving movement of 90 km each year to calving areas (BC Ministry of the Environment 2010).

Monitoring in Labrador established that approximately 10% of individuals move among adjacent sub-populations per year, or for consecutive years, but most of the sub-population remains with the same animals and reuses parts of the landscape each year (Schmelzer pers. comm.). The sub-population can shift to from 10 km to > 100 km in response to natural (e.g., snow, forage, and fires) and anthropogenic (e.g., forestry) factors (Stuart-Smith *et al.* 1997; Dyer *et al.* 2001; Rettie and Messier 2000). Caribou are most sedentary during winter, tend to reoccupy the same wintering areas (Faille *et al.* 2010), and often use frozen bodies of water as travel corridors (Ferguson and Elkie 2004). Movement rates are greatest in late spring (Ferguson and Elkie 2004), when females disperse from one another to give birth. In the NT, Nagy (2011) monitored 140 boreal adult female and reported that their daily movement rate varied between 1.1 km/day in late winter to 5.0 km/day in late fall. In Québec and Labrador, daily movements of the Red Wine Mountains and Lac Joseph sub-populations were 4-7 times lower than those of sympatric migratory sub-populations (Couturier *et al.* 2010). For the same sub-populations during the snow-bound period (December 26-April 30), movement rates were 1.4 and 0.9 km/day, respectively, while it was 2.1 and 1.6 km/day during the rest of the year (Couturier *et al.* 2010). Schmelzer

(2012) reported that daily movements for these sub-populations from 2007-2012 were lowest during late winter and, secondarily, calving, and highest during spring and fall migration where females travelled an average of 3.5 km/day. Movement rates are greatest in late spring (Ferguson and Elkie 2004), when females disperse from one another to give birth.

Interspecific Interactions

Caribou share their range with other large herbivores across Canada. BP range overlaps slightly with Muskox (*Ovibos moschatus*) range in the NT. The following interactions with Caribou were described in the Sahtu Settlement Area in NT:

> *"Some people claimed that muskox cause boreal caribou to abandon areas because of their hair, the noise they make, or because of parasites they transmit in their feces. Other people said they have seen boreal woodland caribou and muskox feeding on the same plants in the same places without competition or exclusion."* COSEWIC (2012; p. 68).

West of Manitoba, BP range overlaps slightly with Wood Bison (*Bison bison*) range. Fischer and Gates (2005) reported strong space use differences between Bison and Caribou, including elevation, slope, and distance from permanent water bodies. Bison showed a strong preference for graminoids while Caribou preferred lichens. As only 10% of their winter diet overlapped, they concluded that exploitative competition between Caribou and Bison was unlikely.

Caribou range reaches the northern limit of many cervids in Canada. Though Caribou spatially separate themselves from other cervids at the stand scale (see **Habitat Requirements** section), their ranges overlap with Moose, White-tailed Deer, Mule Deer, and Elk (*Cervus elaphus*). Caribou habitat needs are different but these species may be found in close proximity, particularly in the southern portion of Caribou range. Overlap of Caribou with some cervids is predicted to increase with a warming climate (Vors and Boyce 2009). These interactions could be highly important with respect to disease/parasite transmission (see **Threats** – Problematic Native Species section)

Caribou are an important food item for numerous predators and a source of scavenged meat. Wolves are the most important predators of Caribou, although Black Bear, Grizzly Bear, Coyote, Cougar (*Puma concolor*), Lynx (*Lynx canadensis*), and Wolverine (*Gulo gulo*) are predators of both adult and calf Caribou (Bergerud 1974; Gustine *et al.* 2006; Boisjoly *et al.* 2010; Pinard *et al.* 2012). Golden eagles (*Aquila chrysaetos*) (Crête and Desrosiers 1995) and Bald Eagles (*Haliaeetus leucocephalus*) may also prey on Caribou calves (Mahoney and Weir 2009; McCarthy *et al.* 2011). Scavenging by Wolverine on Caribou carcasses is important to Wolverine across much of their range.

There has been limited research on subclinical parasitism in Caribou, until recently (Gunn and Irvine 2003; Gunn *et al.* 2011). Gastrointestinal parasites are universally prevalent in *Rangifer* and while the infections may not cause obvious symptoms, they are costly to Caribou (Gunn and Irvine 2003) by reducing fecundity and sometimes even regulating caribou abundance, as suggested by a study on Svalbard Reindeer (Albon *et al.* 2002). Trends in gastrointestinal parasites are unknown but climate warming will likely influence the host-parasite relationship (Gunn *et al.* 2011).

Liver Fluke (*Fasciola hepatica*) is only found in migratory Caribou of northern Québec and Labrador (Lankester and Luttich 1988), where it can reach prevalence of close to 100% (Côté, S.D., and Couturier, S., unpubl. data). However, these migratory sub-populations are overlapping their seasonal range with BP and future transmission remains possible.

Besnoitia tarandi has been documented in Caribou and Reindeer for almost a century, but little is known about its epidemiology, life cycle (Ducrocq *et al.* 2012, 2013) and transmissibility (Kutz *et al.* 2009). This protozoan parasite has emerged as a significant disease-causing agent in migratory Caribou of Quebec (DU4) (Kutz *et al.* 2009) and could be an issue in the adjacent BP. Numerous other parasites and pathogens are suspected to impact, or potentially impact Caribou, such as *Toxoplasma gondii*, *Neospora caninum*, *Babesia* sp., *Giardia* sp., *Mycobacterium avium*, *Erysipelothrix rhusiopathiae*, *Trypanosoma* sp., *Cryptosporidium* sp. (Johnson *et al.* 2010; Kutz pers. comm.). Research is underway to establish the effect on productivity and mortality, and the extent of sub-populations impacted (Kutz pers. comm.).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Numerous aerial surveys and radio-collaring studies have been conducted in each DU to document Caribou abundance, space use, habitat selection, mortality rates, cause of death, and demographic trends. However, estimating Caribou numbers is challenging because of large ranges, low densities, and forest cover that hinders visual surveys. These challenges are most profound for BP across their large range, but GP and NP also have census difficulties because of weather and remoteness. Caribou counts are conducted with aerial surveys and a standardized census method has been proposed (Courtois *et al.* 2003b). Some jurisdictions record animals as calves and mature animals during aerial surveys. Calves in their second autumn are of similar appearance as mature animals, and mature is defined as > 1 year old (Lalonde pers. comm. 2014). New techniques using fecal DNA have been successfully tested (Hettinga *et al.* 2012). Demographic models are commonly used to determine recruitment and survival rates, based on radio-collared animals, and/or aerial surveys.

Few jurisdictions attempt to determine % population change using aerial surveys because of concerns over bias between surveys, particularly if surveys are few over many years. Jurisdictions conducting rigorous surveys over multiple years can more confidently detect trends and % change data exist for Labrador, the GP and NP. If % change data are lacking, the future trend can be predicted from population growth rate data, and the amount of disturbance in each range. Indices of population decline are widely used in Caribou management. The population finite growth rate (Lambda, λ) using a measure of recruitment and mortality (e.g., Hatter and Bergerud 1991; $\lambda=(1-M)/(1-R)$, where M is adult female mortality and R is population recruitment) is often considered the best method for detecting declines (Bergerud 2000). A λ of < 1.0 indicates population decline; a population with a Lambda of 0.90 will decline by 50% in approximately 7 years. A recruitment rate of 15% is considered a threshold for a stable Caribou population when it is coupled with an 85% adult survival rate and normal sex ratios (Bergerud 1980). Bergerud and Elliot (1986) report that 'negative recruitment' (or recruitment that fails to balance adult mortality), occurs at values of < 10-12%, and a preferred value of 15% is used because it offsets uncertainty. Schmelzer (2013) examined population dynamics of three Labrador Caribou sub-populations from 1997- 2012 and indicated that a survival to recruitment ratio of 90/20 was much more likely to result in demographic stability. Calf recruitment rates have been established to be a minimum of 25 calves per 100 cows in order to avoid population decline (Bergerud and Elliot 1998). Environment Canada (2008) suggests a minimum recruitment rate of 28.9 calves per 100 cows.

Newfoundland population

The distribution of the NP has been monitored since the 1800s and abundance and demographic characteristics have been researched since the 1950s. Extensive censuses have been conducted on major sub-populations throughout the island, and Bergerud (1971) compiled and analyzed data collected from the 1900s to 1967. Radio-collaring was initiated in 1979 with more intensive, large-scale sampling in the mid-1990s. Researchers deployed 100 GPS and 99 satellite collars in 2007 to augment an already large (>1,200) sample of collared Caribou; over 2300 Caribou have been radio-collared since 1979 (Pardy Moores pers. comm.). Until 2013, sampling effort remained intensive, with large-scale satellite collar deployments, extensive surveys of sub-population composition, and mortality investigations.

A calf mortality study initiated in 2003 included sub-populations representing different ecological regions and their predators. The 'Caribou Strategy', which ran from 2008- 2013, was a coordinated effort to determine factors driving the decline in the island's Caribou population (Mahoney and Weir 2009), as well as implement predator ecology studies, evaluate Caribou-predator-habitat interactions, conduct predator reduction experiments, increase public knowledge and engage the public. In addition to collaring, aerial surveys and fall classifications have been completed and repeated for all major sub-populations over the duration of the Caribou Strategy (Weir *et al.* 2014). Hunting information is also collected to determine the quality and state of the animals, but also to detect hunting trends.

Gaspésie population

During the 1970s, the GP was studied using sporadic surveys. Since 1983, annual aerial surveys were used to estimate population size, sex ratio, and calf abundance. Radio-tracking occurred from 1975-1977, 1987-1992, 1998-2001, and 2013-present, and data gathered contribute to a better assessment of population size and trends.

All annual population estimates include a correction factor of 0.70 to account for visibility bias, as not all Caribou are seen on the barren lands during the census (Lalonde 2013; Lalonde and Michaud 2013). This correction factor was estimated from 1999 to 2005 when some radio-collars were in use in the three subpopulations. However, visibility and census conditions vary with time, suggesting that this average correction factor may no longer be accurate. Indeed, it may be too low, resulting in an overestimation of the sub-population size (Lalonde pers. comm.).

Boreal population

Population information is vague or absent for many BP ranges. Population estimates are hindered by a lack of standardized animal location data, limited understanding of Caribou movement within and between ranges, and the difficulty in delineating population ranges because occupancy is generally continuous for much of the range (Schmelzer *et al.* 2004; Couturier 2007; Couturier *et al.* 2009; Environment Canada 2011). The lack of known critical habitat in Caribou range in northern Saskatchewan prompted a large population and habitat research program in the Boreal Shield range in 2014 (USask 2014). The National Recovery Strategy has maximum and minimum population estimates derived by aerial surveys. Often, the best available data are a minimum number of Caribou counted during aerial surveys. Correction factors for visibility bias (due to weather or forest cover) are not equally applied over years and ranges, resulting in limited use of minimum counts as a measure of population trend.

Population trend data can be estimated by comparing aerial survey counts conducted over time but this type of data is uncommon in the BP because the large area, low density, and forest cover result in weak confidence in comparing surveys over time. It is more common to assess population status by using aerial surveys, and survival measures to establish population growth rate (Lambda; λ). This depends on surveys conducted several years in succession, which is not common in some jurisdictions. In BC, the objective is to radio-collar 15% of the animals in each range in order to determine calf recruitment and mortality rates (Culling and Culling 2013). In Alberta, Hervieux *et al.* (2013) used adult female and calf survival rates from radio-collared animals to determine Lambda for 11 ranges. Lambda also is used in Ontario (OMNR 2014), Northwest Territories (Larter and Allaire 2014), and Labrador (Schmelzer 2013).

Abundance

Newfoundland population

In 2013, the total population (including calves) was estimated at 31,980 Caribou (NL Gov., unpubl. data). The population of mature Caribou is about 28,240, based on applying this calf recruitment mean to the total population estimated in 2013. Estimates of mature individuals were 74,912 in 1995 (18.7% recruitment) and 66,623 in 2001 (11.7% recruitment) (Weir *et al.* 2014).

Gaspésie population

The total number recorded in 2013 was 91 (all ages), which increases to an estimate of 130 with use of the visibility correction factor. The number of mature animals is estimated as 112, based on subtracting the proportion of calves (14.3%) counted in the autumn survey. The number of Caribou observed during surveys has declined on Mount Albert since 1996. No animals were recorded on Mount Logan in 2012 or 2013. Most (87%) of the animals were recorded on Mount McGerrigle (St-Hugues pers. comm.)

Boreal population

Historical population estimates are only available in some regions (e.g., Lake Superior Ontario; Cringan 1956; Bergerud *et al.* 2007). Organized censuses and studies of the BP occurred within the last 20 years. Based on present scientific and traditional knowledge of its ecology, it is likely that BP was never abundant and never approached the high densities of Caribou recorded in northern tundra. BP numbers vary widely among jurisdictions (Table 1).

Table 1. Population estimates for the Boreal population designatable unit across their range in eight Canadian provinces or territories. Data deficiencies are as noted (summarized from Environment Canada 2012, Appendices F, G).

Jurisdiction	Population estimate (min.-max.)	Range size (km^2)	Local ranges delineated	Local ranges surveyed
Alberta	2,074-2,315	146,047	12	12
British Columbia	1,040-1,110	25,999	5	5
Labrador	2,983 [2909][a]	155,895	3	3
Manitoba [bc]	1,063-1,543	211,865	13	10
NT	6,500	441,665	1	1
Ontario [bcd]	1,284-5000	497,554	9	3
Québec [be]	7,091	680,433	6	6

Jurisdiction	Population estimate (min.-max.)	Range size (km^2)	Local ranges delineated	Local ranges surveyed
Saskatchewan [b c f]	No data	286,273	2	No data
Canada (Total)	**24,722-30,513**	**2,445,731**	**51**	**40**

[a] Estimate of approximately 2909 from aerial surveys in 2014.

[b] More Caribou ranges exist but have not been delineated yet.

[c] Underestimated; some population estimates were missing in these provinces.

[d] Total Boreal Caribou estimate of 5000; Footnote 7, Appendix F of Environment Canada (2012).

[e] Current estimate for Québec ranges from 5980 to 8570 (Équipe de rétablissement du caribou forestier du Québec 2013; St-Laurent pers. comm. 2014).

[f] In Saskatchewan, Environment Canada (2011) estimated 4380 Caribou.

Table 2. Population estimate and range size for local populations identified in the Federal Recovery Strategy for Boreal Caribou. Local populations are presented by viability as self-sustaining, not self-sustaining, and local populations with uncertain viability. 'Range name' is the name of the local population range. Range ID refers to provincial acronyms. (Source: Environment Canada 2012).

Range ID	Range name	Range area (ha)	Range area (km^2)	Population size (min)	Population size (max)	Max. Density (#/100 km^2)
SELF-SUSTAINING						
MB10	Manitoba South	1,867,255	18,673	?	?	
MB11	Manitoba East	6,612,782	66,128	?	?	
MB12	Atikaki-Berens	2,387,665	23,877	300	500	2.09
MB4	Reed	357,425	3,574	100	150	4.20
MB7	Wabowden	628,938	6,289	200	225	3.58
MB8	Wapisu	565,044	5,650	110	125	2.21
NT1	NT	44,166,546	441,665	6,500	6,500	1.47
ON3	Churchill[a]	2,150,490	21,505	? (262)[b]	?	
ON5	Nipigon[a]	3,885,026	38,850	300 (172)[b]	300	0.77
ON6	Coastal	376,598	3,766	492	492	13.06
ON7	Pagwachuan[a]	4,542,918	45,429	? (164)[b]	?	
ON9	Far North	28,265,143	282,651	?	?	
QC5	Manicouagan	1,134,129	11,341	181	181	1.60
QC6	Québec	62,156,186	621,562	9,000	9,000	1.45
SUB-TOTAL		**159,096,145**	**1,590,961 (65.1%)[c]**	**17,183**	**17,473 (68.5%)[c]**	
NOT SELF-SUSTAINING						
AB1	Chinchaga (with BC)	3,162,612	31,626	250	250	0.79
AB10	Cold Lake	672,422	6,724	150	150	2.23
AB11	Nipisi	210,771	2,108	55	55	2.61

Range ID	Range name	Range area (ha)	Range area (km^2)	Population size (min)	Population size (max)	Max. Density (#/100 km^2)
AB12	Slave Lake	151,904	1,519	65	65	4.28
AB2	Bistcho	1,436,555	14,366	195	195	1.36
AB3	Yates	523,094	5,231	350	350	6.69
AB4	Caribou Mountains	2,069,000	20,690	315	394	1.90
AB5	Little Smoky	308,606	3,086	78	78	2.53
AB6	Red Earth	2,473,729	24,737	172	206	0.83
AB7	West Side Athabasca	1,572,652	15,727	204	272	1.73
AB8	Richardson	707,350	7,074	150	150	2.12
AB9	East Side Athabasca	1,315,980	13,160	90	150	1.14
BC1	Maxhamish	710,105	7,101	300 (132)[d]	300	4.22
BC2	Calendar	496,393	4,964	290 (135)[d]	290	5.84
BC3	Snake-Sahtahneh	1,198,752	11,988	360 (321)[d]	360	3.00
BC4	Parker	75,222	752	40 (59)[d]	60	7.98
BC5	Prophet	119,396	1,194	50 (35)[d]	100	8.38
MB2	Kississing	317,029	3,170	50	75	2.37
MB3	Naosap	456,977	4,570	100	200	4.38
MB6	William Lake	488,219	4,882	25	40	0.82
NL2	Red Wine Mountain	5,838,594	58,386	97	97	0.17
ON1	Sydney	753,001	7,530	? (55)[b]	?	
ON8	Kesagami	4,766,463	47,665	492 (164)[b]	492	1.03
QC1	Val-d'Or	346,861	3,469	30	30	0.86
QC2	Charlevoix	312,803	3,128	75	75	2.40
QC3	Pipmuacan	1,376,899	13,769	134	134	0.97
SUB-TOTAL		**31,861,389**	**318,614 (13%)[c]**	**4,117**	**4,568 (17.9%)[c]**	
UNCERTAIN STATUS[e]						
MB1	The Bog	446,383	4,464	50	75	1.68
MB13	Owl-Flinstone	363,570	3,636	78	78	2.15
MB5	North Interlake	489,680	4,897	50	75	1.53
MB9	Manitoba North	6,205,520	62,055	?	?	
NL1	Lac Joseph	5,802,491	58,025	1,282	1,282	2.21
NL3	Mealy Mountain	3,948,463	39,485	1,604	1,604	4.06
ON2	Berens	2,794,835	27,948	? (237)[b]	?	
ON4	Brightsand	2,220,921	22,209	? (224)[b]	?	
QC4	Manouane	2,716,449	27,164	358	358	1.32
SK1	Boreal Shield[f]	18,034,870	180,349	?	?	
SK2	Boreal Plain	10,592,463	105,925	?	?	

Range ID	Range name	Range area (ha)	Range area (km^2)	Population size (min)	Population size (max)	Max. Density (#/100 km^2)
SUB-TOTAL		53,615,645	536,156 (21.9%)[c]	3,422	3,472 (13.6%)[c]	
TOTAL		244,573,179	2,445,732	24,722	25,513	

Note:

[a] Re-assessed in 2014 as being uncertain whether the range is self-sustaining (OMNR 2014).

[b] Minimum population count results from OMNR (2014); numbers are not part of total population estimate.

[c] Percentage of the total of all ranges.

[d] Minimum population counts results from 2013 (Culling and Culling 2013); numbers are not part of total population estimate.

[e] 'Uncertain Status' indicates population is 'as likely as not self-sustaining' (Environment Canada 2012).

[f] Boreal Shield local population was not assessed for sustainability.

The BP was estimated at 33,000 in 2002 (COSEWIC 2002), and 34,000 in 2012 (Environment Canada 2012). A maximum of 25,513 is estimated from those sub-populations with data (Table 2), and an additional 8000 animals are estimated for the remaining sub-populations. Although these numbers were based on best available information, they are only a crude approximation and the population is actually unknown. In Quebec, for example, the estimate of 7,091 animals is based on extrapolation of density from several study areas to the known range in the province. Data quality on density and abundance are variable across BP range and some range population estimates were missing.

Survival and recruitment

Predation is the main proximate factor limiting Caribou population growth because the survival of calves to one year of age is usually low and is often insufficient to compensate for annual adult mortality in declining populations (Bergerud 1974; Stuart-Smith *et al.* 1997; DeMars *et al.* 2011). Recruitment rates are expressed as actual survival derived from mortality records and survival models, or as an index of the ratio of cows to calves recorded in aerial surveys conducted in the fall (see **Sampling Effort and Methods** section for stability thresholds).

Newfoundland population

In the NP, adult survival is high (combined mean of 86%; range: 82-92%) for all sub-populations that have been studied between 2004 and 2010. Calf survival is not significantly different between males and females, though males do have a slightly lower survival rate than females (Lewis and Mahoney 2014).

Calf survival rates were estimated in the 1980s and 1990s for many NP sub-populations (Table 3) and averaged 62% for the first six months before declining to a mean of 35% between 2003 and 2012 (Lewis and Mahoney 2014; Figure 4). Trindade *et al.* (2011) reported an extremely low annual calf survival rate of 4% (SD: 5%) for the Middle Ridge, Gaff Topsails, and Mount Peyton sub-populations between 2003 and 2007. Calf survival has greatly increased since 2007, with rates near 50% in 2009 and 2012 (Figure 4). Data from 2003 to 2012 (Figures 4, 5) suggest the decline in recruitment has halted (Weir *et al.* 2014; Lewis and Mahoney 2014).

Table 3. Calf survival and recruitment values for Newfoundland (NP) and Boreal Population (BP) designatable units in Canada.

Designatable Unit/ Sub-population	Years[a]	Calf survival (%)[b]	Recruitment (%, or calf/100 females)[c]	Source
Newfoundland Population (NP)				
Several sub-populations	1979-97	67 (to 6 months)		Lewis and Mahoney 2014
3 sub-populations	2003-07	4 ± 5 (SD)		Trindade *et al.* 2011
Middle Ridge	1990s		25-30% [d]	Mahoney and Weir 2009
Middle Ridge North	2003-05	5 (1-12)		Lewis and Mahoney 2014
	2006-11	20 (6-36)		
	2012	38		
Middle Ridge South	2003-05	13 (11-15)		
	2006-11	0.5 (0-2)		
	2012	23		
LaPoile	2007-11	24 (5-40)		
	2012	26		
Mount Peyton	2003	11		
Northern Peninsula	2008-11	25 (3-41)		
	2012	41		
NP all sub-populations	1966-97		40.8 c/100F [d]	Weir *et al.* 2014
	2003-12	35	16.3 c/100F [d]	Lewis and Mahoney 2014
Boreal Population (BP)				
6 ranges in British Columbia	2009-10 2013		17 c/100F 21 c/100F, 13.4%	Thiessen 2009, BC MoE 2010 Culling and Culling 2013
Alberta (8-13 sub-populations)	2001-08		18 c/100F	AB Caribou Committee
Alberta (11 sub-populations)[e]	1998-12		15 c/100F	Hervieux *et al.* 2013
Saskatchewan	1993-96		28 c/100F	Rettie and Messier 1998
NT - Dehcho	2005-14		36 c/100F[g]	Larter and Allaire 2014
NT - South Slave	2004-10		24 c/100F	Kelly and Cox 2011
Ontario; Berens	2011-12		10.7 c/100F	OMNR 2014
Sydney			15.7 c/100F	

Designatable Unit/ Sub-population	Years[a]	Calf survival (%)[b]	Recruitment (%, or calf/100 females)[c]	Source
Churchill			15.6 c/100F	
Brightsand	2010-12		22 c/100F	
Nipigon	2009-12		33.1 c/100F	
Pagwachuan			21.6 c/100F	
Kesagami			19.4 c/100F	
Swan			16.1 c/100F	
Spirit	2008-11		20.1 c/100F	
Kinlock			12.2 c/100F	
Ozhiski			17.2 c/100F	
James Bay			18.8 c/100F	
Missisa			14.2 c/100F	
Avg. 13 sub-populations	2008-12		18.2 c/100F	
Québec		53 (to 30 d) 43 (to 90 d)		Leclerc *et al.* 2012
Charlevoix		46 (to 50 d)		Pinard *et al.* 2012
Labrador; Mealy Mtns.	1971		26.1%	Schmelzer 2013
	1974-77		18.9% (14.8-21.1)	
	1987		17.7%	
	1994		12.8%	
	2002		28.8%	
	2005		16.3%	
	2008-09		16.0% (13.8-18.2)[f]	
	2011-12		12.5% (10.5-14.5)f	
Red Wine Mountains	1974		12.5%	Bergerud *et al.* 2008
	1984 1987 2009		16.4% 19.2% 11.8%	Schmelzer 2013
	2001-03		19.3% (12.3-26.9)	
Lac Joseph	1984-86		19.5% (15.2-23.1)	St-Martin 1987
	1998-01		14.9% (11.9-15.7	Schmelzer 2013
	2002-05		16.8% (15-19.7)	
	2007-09		20.9% (1.5-23.6)	

[a] Data not necessarily collected annually.

[b] Annual survival, or mean annual survival for multi-year survey periods.

[c] Annual rate, or mean annual rate for multi-year survey periods. Range in brackets. Surveys are conducted in autumn/early winter when calves are approximately 6 months old.

[d] Estimated from fall classification.

[e] Sub-populations overlap with those from 2001-2008.

[f] Data do not include Joi River subpopulation.

[g] Recruitment estimate is based on March survey, when calves are 8 months old.

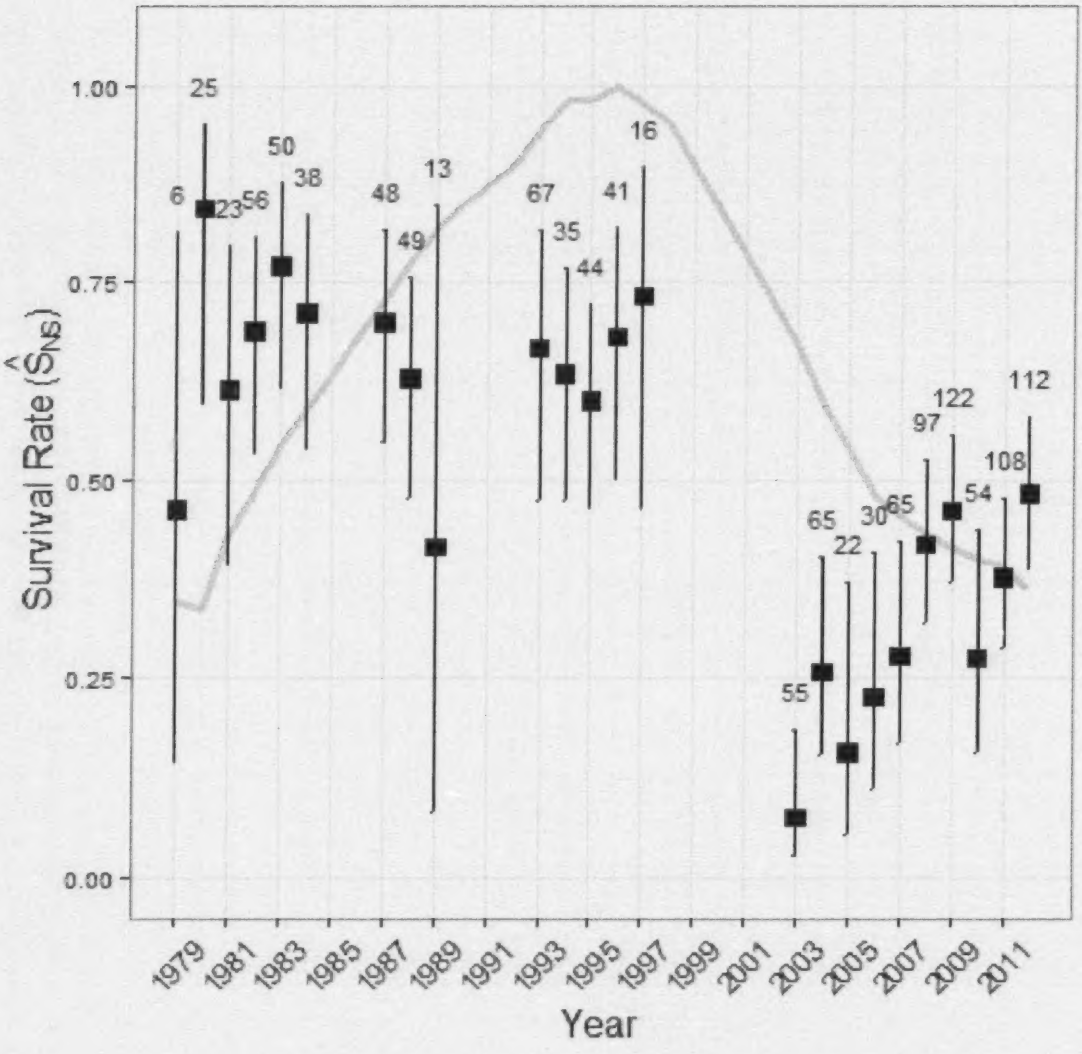

Figure 4. First six-month survival of Newfoundland Caribou calves, 1979-2012, with 95% confidence intervals. Population size is predicted to increase when survival exceeds 45%. The solid line indicates relative population size. Source: Lewis and Mahoney (2014).

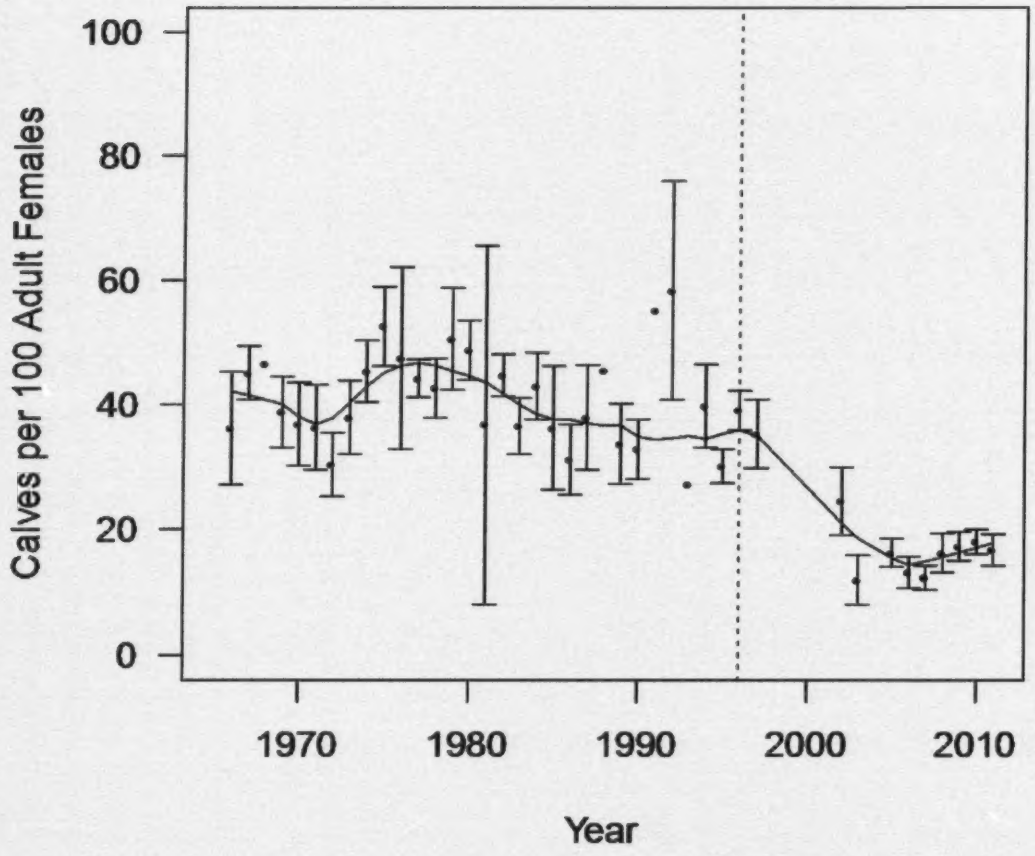

Figure 5. Caribou calf abundance (# calves/100 adult female) recorded in autumn, Newfoundland, 1966-2011. A ratio > 25-29 calves/100 females is associated with a stable population. The solid line is a loess smoothing curve used to illustrate trend. The vertical dotted line indicates when population abundance was at its peak. Source: Weir *et al.* 2014.

Sub-population composition surveys across Newfoundland indicate that the proportion of females giving birth declined slightly, but considerable variation exists among sub-populations (Mahoney and Weir 2009). The Pot Hill and Grey River sub-populations both showed steady declines, whereas other sub-populations only showed slight declines in calf production. These sub-population-specific trends may reflect the differential availability of forage resources, which results in differences in the female reproductive potential and lower calf weight (Mahoney and Weir 2009). A greater weight at birth has been correlated with increased calf survival in BP range (Pinard *et al.* 2012) and recent analyses on a larger data set (2003-2011) indicated a similar relationship in Newfoundland (Lewis and Mahoney 2014).

Predator vulnerability is inversely related to prey age. For example, the majority of deaths due to predation occur within the first 12 weeks of a Caribou calf's life, and >70% of calves that survive until fall will reach one year of age (Mahoney and Weir 2009).

Gaspésie population

Female adult survival was 92% from 1987 to 1992, but later declined to 83% in 1999-2000 (Table 4). More recent data for adult mortality suggests that more adults than expected are subject to predation by Coyote (St-Laurent pers. comm. 2014). Predator control programs were initiated if these annual surveys indicated low recruitment. Between 1990 and 1996, a predator control program was implemented with short term, positive results (Crête and Desrosiers 1995). Predator control resumed in 2001 and has continued since then. Until 2011, calf recruitment values were often far below the 17% threshold set as a goal for a stable sub-population by the Équipe de rétablissement du caribou de la Gaspésie (Figure 6). Lesmerises (2012) underlined that this threshold could be underestimated and, considering the current rate of adult mortality, the threshold should be a minimum of ~21% to reach population stability. In 2012 and 2013, the proportion of juveniles was high, which may result in increased recruitment if they survive. The proportion of juveniles probably increased because of the indirect effect of climate on cow's condition during pregnancy, and predator's access to the summit during calving (M.-H. St-Laurent, unpubl. data).

Table 4. Annual survival rates for adult female Caribou for various sub-populations across Canada.

Province/ Regions	Sub-populations	Years[a]	Mean Survival Rate %[b]	Source
NP DU5				
	5 sub-populations	2004-11	87 (CI: 83-91)	Lewis and Mahoney 2014
GP DU11				
Gaspésie		1987-92	92	Crête and Desrosiers 1995
		1999-00	Males: 79 (CI: 57-100) Fem.: 83 (CI: 67-95)	Fournier and Faubert 2001
BP DU6				
Alberta	8-13	2001-08	86 (range 82-91)	Alberta Caribou Committee
	11	1994-12	85 (range 77-91)	Hervieux *et al.* 2013
NT	Dehcho	2005-14	77 (range 62-88)	Larter and Allaire 2014
	South Slave	2004-10	85 (range 76-91)	Kelly and Cox 2011

Province/ Regions	Sub-populations	Years[a]	Mean Survival Rate %[b]	Source
Sask.	5 sub-populations	1993-96	84 (CI: 75-93)	Rettie and Messier 1998
Manitoba	North Interlake	2005-09	Males: 65 (CI: 54-75) Fem.: 76 (CI: 65-85)	Hettinga *et al.* 2012
Québec	3 sub-populations	2003-11	87 (range 75-100)	Rudolph *et al.* 2012
			90 (range 75-100) (hunting excluded)	
Labrador	Mealy Mtn.	1985-87	85	Schmelzer 2013
		2002-05	92 (range 83-97)	
		2006-09	92 (range 91-93)	
		2010-12	93 (range 92-93)	
	Red Wine M.	1981-88	80 (SE=5.2)	Schaefer *et al.* 1999
		1993-97	70 (SE=5.4)	
		1997-00	75 (range 60-92)	Schmelzer 2013
		2001-04	84 (range 77-95)	
		2005-09	82 (range 70-89)	
	Lac Joseph	1984-87	95 (CV=0.05, range 89-100)	St-Martin 1987
		1998-09	84 (CV=0.05, range 69-100)	Schmelzer 2013

[a] Data not necessarily collected annually.

[b] Annual rate, or mean annual rate for multi-year survey periods. Range, confidence interval, standard error, or coefficient of variation in brackets.

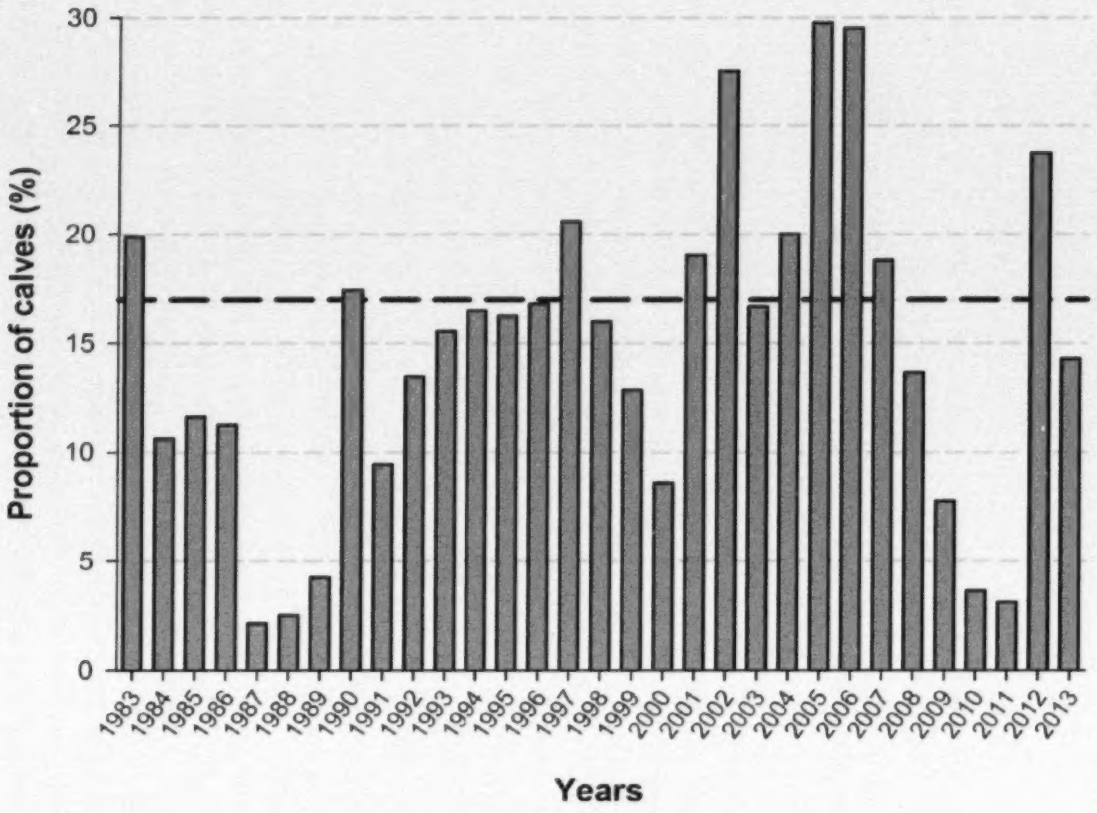

Figure 6. Proportion of calves (%) in autumn surveys of Gaspésie Caribou, 1983-2013. The dashed horizontal line shows the target of 17% set in the Recovery Plan to achieve a stable population. Predator control programs were conducted between 1990-1996, and since 2001. Source: M.-H. St-Laurent, adapted from Ministère des Forêts, de la Faune et des Parcs du Québec, unpubl. data.

Boreal population

Annual adult female survival generally is high (i.e., >75%; Table 4) but fluctuates depending upon levels of hunting. For example, adult female survival for the Lac Joseph sub-population in Labrador was significantly higher between 1984 and 1987, when compared to estimates from 1998-2009 (Table 4; Schmelzer 2013). Using knowledge that deaths from hunting accounted for 30% of all known mortalities, Schmelzer (2013) calculated that mean survival of females over the monitoring period increased by 6% when hunting-related mortality was excluded and this difference in mean survival rates could have significant consequences for long-term population growth. Under natural conditions, adult female survival is characterized by higher survival rates and lower variation. In the Nottaway, Témiscamie, and Assinica sub-populations in Québec, Rudolph *et al.* (2012) calculated female survival at 87% with and 90% without hunting effects for the Témiscamie and Assinica sub-populations in Québec; at this rate, their models predicted declining adult survival over time (Table 3).

Recruitment rates (often expressed as # calves per 100 females) are highly variable (Table 3). In the Alberta populations, mean recruitment from 2001 to 2008 was 18 calves:100 females, but ranged from 3 to 52 calves:100 females. Populations in southern parts of BP range generally have rates below a sustainability threshold (*i.e.*, 29 calves per 100 females) while rates in northern parts of the range are higher (*i.e.*, 36 calves per 100 females (range: 17-67) in the NT (Larter and Allaire 2014).

Fluctuations and Trends

Newfoundland population

Dramatic population fluctuations have occurred in the NP since surveys were first conducted. Anecdotal estimates on the NP date to the early 19th century and historic documents show that the NP peaked in the early 1900s at an estimated 100,000 individuals and declined to 10,000-15,000 between 1925 and 1935 (Peek *et al.* 2012). Systematic surveys and research began in the 1950s. The NP slightly increased from 1930 to 1950 but did not approach the same abundance as in the early 1900s, as suggested by historical hunting records and ecological knowledge (Peek *et al.* 2012). The NP increased until about 1975 when the population reached approximately 22,500 individuals (16,589 mature) (Peek *et al.* 2012) and from this point, the population increased to 94,000 in 1996 then declined to 68,000 in 2002, and further to approximately 33,000 Caribou in 2012 (Weir *et al.* 2014) (Figure 7). This represents a decline of 58% and 65% in the past 12 and 18 years respectively (2 and 3 generation times; see **Life Cycle and Reproduction** section). Similar patterns were observed for most individual sub-populations in the NP.

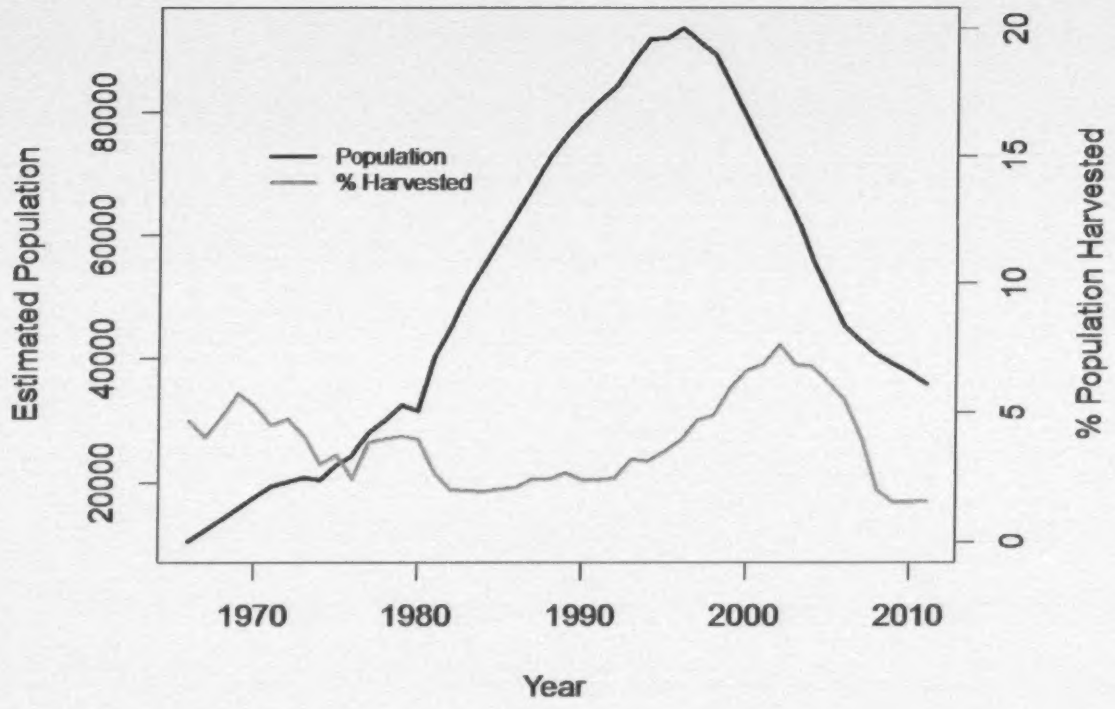

Figure 7. Changes in the population abundance of Newfoundland Caribou and hunting harvest rate, 1966-2011. Source: Weir *et al.* (2014).

It is believed that the decline of Caribou in Newfoundland is part of a natural fluctuation and that population size will increase (Bastille-Rousseau *et al.* 2013; Lewis and Mahoney 2014; Weir *et al.* 2014). The decline was related to density- dependence effects associated with poor range conditions (Bastille-Rousseau *et al.* 2013), and excessive hunting levels occurring as the population was beginning to decline (Weir *et al.* 2014). The conclusion that density-dependence effects exist is based on decreased calf survival as the population increased and increased calf weight when Caribou density was lower, both of which suggest populations were being limited because of high Caribou densities. Increased calf weight was likely due to better condition of breeding females (Trindade *et al.* 2011; Weir *et al.* 2014), and larger calves had a better chance of survival (Mahoney and Weir 2009; Lewis and Mahoney 2014). Other indices suggestive of density-dependence effects included altered habitat use (Mahoney and Schaefer 2011), as well as increased tooth wear and body morphology changes (Mahoney *et al.* 2011). Changes to the timing of annual migrations also were noted during high and lower density periods, with some sub-populations spending 5 weeks less on summer range when density was high, possibly due to competition for limited forage (Mahoney and Schaefer 2002b; Weir *et al.* 2014). Body size of female Caribou decreased through time, and some sub-populations exhibited

substantial reductions in male stature and antler size, changes typically associated with limited forage quality and quantity (Mahoney and Schaefer 2002b; Mahoney and Weir 2009). Peek *et al.* (2012) concluded that although predation is the main proximate cause of the NP decline, density-dependence through summer range deterioration may constitute an ultimate cause.

Hunting is also believed to have been a factor in the recent decline. Between the 1960s and 2012, 3.8% of the population was harvested annually (Figure 7; Weir *et al.* 2014). However, hunting in the early years of the population decline exacerbated the decline. Licence sales increased steadily until 2004, resulting in an 8-year lag from the population peak to quota reduction that resulted in the highest rates of harvest (5.9%–7.6% from 1999 to 2005) during the period of rapid population decline. The overall rate of harvest peaked at > 12% for some individual sub-populations, and > 18% when considering only the adult male segment of the population (Weir *et al.* 2014). Mean harvest rate was highest (7.6%) during the steepest rate of decline (1999-2005), and maximum harvest rates were recorded in sub-populations such as La Poile at 12.3% in 2004 and Grey River at 17.8% in 2007 (Weir, J. and Luther, G., NLDEC, unpub. data).

The future trend in the NP has been predicted based on scenarios with, and without, increased calf recruitment. Leslie matrix population models, which use calf survival, productivity, adult survival, and age of breeding females to forecast future population abundance, suggested that if calf recruitment remained low, the NP would decline by 90% to approximately 5,074 individuals by 2035, whereas an increase in recruitment following higher calf survival would stabilize population change or initiate population increase by 2035 (Weir *et al.* 2014; Figure 8). Based on these models, a 40-45% annual calf survival is required to stabilize the NP. Note that the average calf survival during the population increase period (1980-1996) was 67.4 +/- 9.1% (Lewis and Mahoney 2014).

The rate of decline is slowing, with a decline of 9%/year between 2000 and 2006 to 5%/year since 2007, and this change is likely due to improved calf survival and reduced hunting pressure (Weir *et al.* 2014). Calf survival has increased to 48% in 2012 and is expected to be stable (see **Survival and Recruitment** section). Body size (jawbone length and antler size) have increased since the mid-2000s and have returned to pre-decline levels (Weir *et al.* 2014). Weight of male and female calves has returned to pre-decline levels (Weir *et al.* 2014)

In summary, the present decline is density-dependent in nature and believed to ultimately be due to nutritional stress from food limitation. Caribou calf vulnerability increased with density, allowing exploitation by predators to be a driving mechanism of decline. The rate of population decrease was exacerbated by hunting in the early part of the decline, but quotas have since been decreased. Various indices suggest a healthier population and that the decline is slowing and may be halting.

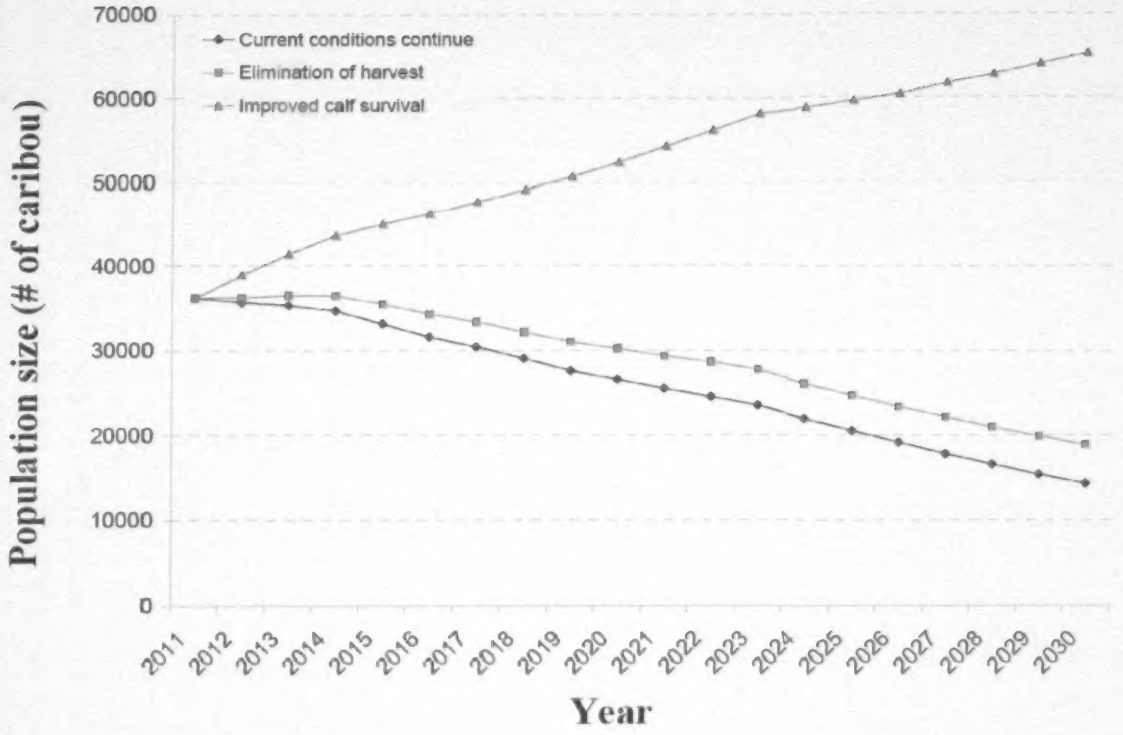

Figure 8. Newfoundland Caribou population simulation using Population Viability Analysis: (1) continuing current low calf survival rates, (2) elimination of hunting, and (3) improved calf survival rates. Source: Randell *et al.* (2012).

Gaspésie population

The GP has declined since population size was first estimated in the 1950s at 700-1,500 individuals (calves and mature animals combined) (Moisan 1958). The population was estimated at 274 (219 mature) in 1983, declined later to a low of 100 (88 mature) in 1999, and increased again to 214 (174 mature) animals in 2007 (St-Laurent pers. comm.; Figure 9). The GP was at its lowest recorded levels in recent years, with estimates of 92 (89 mature) animals in 2011, and 85 (65 mature) animals in 2012. A population trend is difficult to assess over any single time period because the fluctuations mean that comparisons within the dataset can yield dramatic increases or decreases. The two-generation trend (12 years; see **Life Cycle and Reproduction** section; 2001-2013) is highly variable depending upon which 12-year period is used. An averaged rate over 5, 12-year periods from 1997-2013 was -10% (range: +1, to -47%). Similarly, an averaged rate over 5, 18-year periods from 1991-2013 for the three generation trend is -11% (range: +15, to -34%). The trend since 1983 has been -49%. The approximate decline since the 1950s likely is 81-91% (*i.e.*, 700-1500 Caribou in the 1990s, to 130 Caribou in 2013).

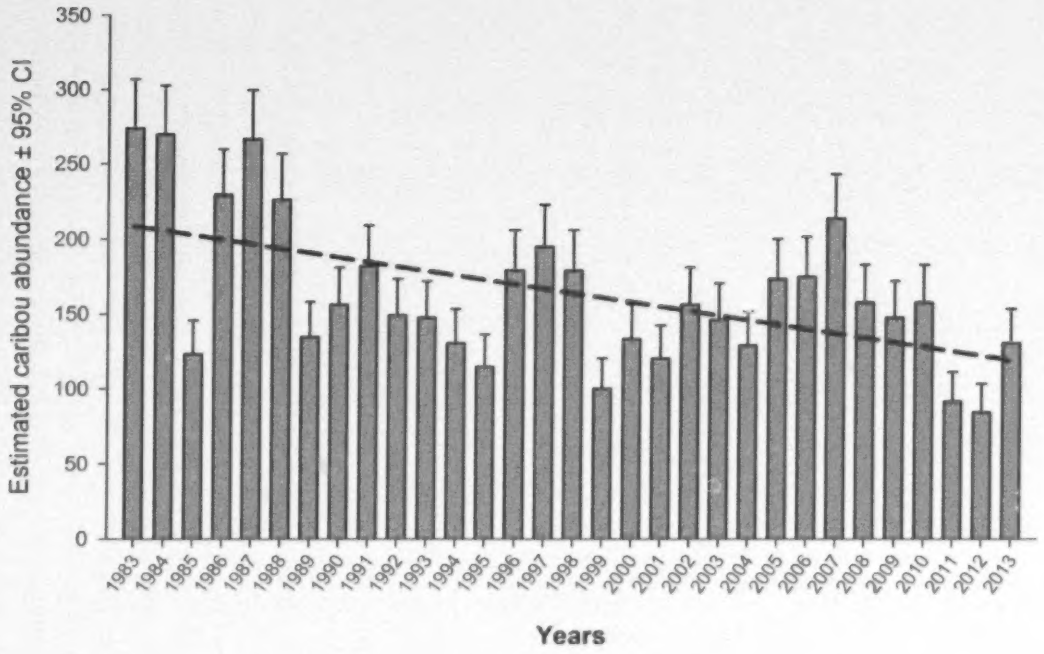

Figure 9. Autumn population estimates (using visibility correction factor of 0.70) of all ages within the Gaspésie population, 1983-2013. Source: M.-H. St-Laurent, adapted from Ministère des Forêts, de la Faune et des Parcs du Québec, unpubl. data.

The future trend in the GP has been estimated using a population viability analysis (PVA). Lesmerises (2012) demonstrated that the average time to extinction would be 20.5 years (± 6.7 years) if calf mortality of the GP remains at 89%, which is the mean level reported in 2009-2011. No iteration goes beyond 2057 with this modelling scenario. This PVA suggested that calf survival must remain between 41 and 43%, or approximately 33 calves:100 females to assure sustainability for the next 100 years, which is similar to the rate of 40 to 45% reported for the NP population (Randell *et al.* 2012). Lesmerises (2012) also demonstrated the importance of adult survival on the GP trends, but results should then be interpreted with caution as some missing data from this analysis was acquired from other Caribou populations. Recent surveys suggested that adult mortality could be higher than expected, and that adult females could be more vulnerable to predation by Coyote (M.-H. St-Laurent, unpubl. data).

Boreal population

The % change trend in the last 3 generations (18 years – see **Life Cycle and Reproduction** section) for the BP population as a whole is unknown. A large part of the DU remains unsurveyed, and surveys within ranges over long periods are difficult to compare with one another. The last status report (COSEWIC 2002) estimated there were 33,000 Caribou, which is similar to the 2012 National Recovery Report (Environment Canada 2012) estimate of 34,000 BP Caribou. These are considered to be crude estimates of population size, particularly in the large areas of northern ranges, where abundance is believed to be high (*i.e.*, 6,500 in NT, and 7,000 in Quebec; Table 1). An earlier (early 2000s) crude estimate for four sub-populations in southern James Bay was 700 Caribou (Rudolph *et al.* 2012). Some regions have undertaken new surveys since the National Recovery report, but trend data is still difficult to obtain. For example, in BC, a recent (2013) minimum population count of all ranges recorded 952 Caribou (816 adults), which is a decline of 37% (all ages) from the 2004 estimate, and a decline of 29% from the lower confidence interval estimate (Culling and Culling 2013). However, population density may have been overestimated for some ranges used in the 2004 estimate, and comparisons are thus difficult. Even though percent decline is equivocal in BC, a decline still appears evident because 6 of 8 ranges and sub-ranges had unsustainable calf recruitment rates.

Trend data using population growth rate exists for some jurisdictions and indicates population decline in almost all ranges (Table 5). Lambda values for a period approximating the last 3 generations (1996-present) are available for 37 sub-populations covering 46 time periods. A 'time period' is a short period of several years, which was used to limit masking of possible years where Lambda was positive. The sub-populations represent > 90% of the BP range. (Note: some sub-populations do not correspond to population ranges in the National Recovery Strategy, i.e., BP South and BP North in NT are separated here, and the five sub-populations in Saskatchewan equate to a single population range in the National Recovery Strategy). Only some Labrador sub-populations in some years, and a single population (northern NT section range), indicated population growth. In the Sahtu Settlement Area in the NT, there is a general consensus among Aboriginal users that local Caribou populations are currently healthy, as reported by SRRB (2010). In Labrador, even with higher Lambda values, the Red Wine Mountain sub-population has not recovered from a major decline during the 1990s (Schaefer *et al.* 1999; Schmelzer 2013) and a recent assessment of the Mealy Mountain and Lac Joseph sub-populations also indicates decline (Schmelzer 2013).

Table 5. Finite rate of population change in the Boreal population designatable unit by sub-population or jurisdiction. Average Lambda values given for best available time period within three generations (18 years). A Lambda < 1 equates to population decline.

Province/ region	Sub-population	Years[a]	Lambda (range)[b]	Source
Alberta	13 sub-populations	2001-08	0.93 (0.69-1.19)	http://www.albertacaribouccommittee.ca
	Bistcho	5 years	0.84 (-58 %)[e]	Hervieux *et al.* 2013

Province/ region	Sub-population	Years[a]	Lambda (range)[b]	Source
	Chinchaga	10 years	0.89 (-70%)	
	Cold Lake	12 years	0.86 (-87%)	
	Cold L. Sask	12 years	0.92 (-63%)	
	Caribou Mtn	17 years	0.92 (-76%)	
	ESAR	17 years	0.92 (-78%)	
	Little Smoky	13 years	0.97 (-33%)	
	Red Earth	15 years	0.88 (-84%)	
	Richardson	3 years	0.98 (-5%)	
	WSAR	18 years	0.93 (-71%)	
	Yates	5 years	1.00 (+1%)	
	Average	1994-12	0.92 (- 57%)	
NT	Dehcho	2005-14	0.97 (0.72-1.29)	Larter and Allaire 2014
	South Slave	2004-10	0.96 (0.83-1.06)	Kelly and Cox 2011
	Gwich'in S.	2003-07	1.08	Nagy 2011
	Gwich'in N.	2005-07	1.2	Nagy 2011
	BP South		0.87-0.97	
Sask.	Mossy	1993-96	1.1	Rettie and Messier 1998
	Montreal	1993-96	0.91	
	Nemeiben	1993-96	0.84	
	Clarke	1993-96	0.92	
	Weyakin	1993-96	0.98	
	Avg.[f]	1993-96	0.95	
Manitoba	N. Interlake	2005-09	0.90 (0.82-0.99)	Hettinga *et al.* 2012
Ontario	Berens	2011-12	0.93 (0.89-0.98)	OMNR 2014
	Sydney	2011-12	0.98 (0.97-0.99)	
	Churchill	2011-12	0.96 (0.94-0.98)	
	Brightsand	2010-12	0.87 (0.86-0.90)	
	Nipigon	2009-12	0.98 (0.96-0.99)	
	Pagwachuan	2009-12	0.94 (0.72-1.05)	
	Kesagami	2009-12	0.94 (0.88-1.01)	
	Spirit	2008-11	0.95 (0.82-1.06)	
	Kinlock	2008-11	0.95 (0.91-1.01)	
	James Bay	2008-13	0.91	
	Missisa	2008-13	0.86	
	Average	2008-13	0.93 (0.82-1.06)	

Province/ region	Sub-population	Years[a]	Lambda (range)[b]	Source
Québec	Assinica	2003-12	0.98	Rudolph *et al.* 2012
	Nottaway	2002-11	0.98	
	Temiscamie	2002-12	0.98	
Labrador	Mealy Mtns.	1960	0.78[c]	Schmelzer 2013
		1963	0.81[c]	
		1970-71	1.0 (0.99-1.02)[c]	
		1974-75	0.86 (0.69-1.08)[c]	
		1981	1.16[c]	
		1987	1.18[c]	
		2002	1.17[d]	
		2005-06	1.12 (1.11-1.13)[d]	
		2008-10	1.14 (1.07-1.25)[d]	
		2011-12	1.06 (1.04-1.08)[d]	
	Average	2002-12	1.13 (1.07-1.25)[d]	
	Red Wine	1997	0.69[d]	
	Mtns.	2001-03	1.03 (0.88-1.12)[d]	
		2009	1.1[d]	
	Average	1997-09	1.05 (0.69-1.16)[d]	
	Lac Joseph	1984-86	1.2 (1.16-1.19)[c]	
		1998	0.95[d]	
		2000-02	0.99 (0.84-1.18)[d]	
		2003	0.87[d]	
		2005	0.97[d]	
		2007-09	1.15 (0.88-1.31)[d]	
	Average	1998-09	1.08 (0.84-1.3)[d]	

[a] Data not necessarily collected annually.

[b] Annual rate, or mean annual rate for multi-year survey periods. Range in brackets.

[c] Based on successive population estimates.

[d] Based on a function of survival, mortality, and calf recruitment (e.g. Hatter and Bergerud 1991).

[e] Cumulative realized population change for different time periods between 1994-2012 (Hervieux *et al.* 2013).

[f] The 5 sub-populations in Saskatchewan roughly equate to SK1 (Boreal Plain) population range in Environment Canada (2012).

The averaged Lambda for the 37 subpopulations is 0.96, indicating population decline (Table 5). The declines may be short term but this is unlikely because data sets covered short, 2-4 year periods and positive Lambda would be noted. Negative Lambda existed in 30 sub-populations (81% of all sub-populations with data) and 30 time periods. In Alberta, enough data from 998 radio-collared Caribou in 11 of the 13 Albertan ranges indicated 10 ranges were in decline, with mean adult female survival of 85%, mean number of 14.5 calves/100 females, and mean $\lambda = 0.92$ (Hervieux *et al.* 2013). In Ontario, Lambda values indicate a decline in all 11 ranges with data, and a mean Lambda of 0.93, from 2008-2012 (OMNR 2014). Lambda is < 1 in regions with highly disturbed ranges (e.g. Alberta) but Lambda also was lower in areas considered to be relatively less disturbed (e.g., Ontario and Québec, southern NT). A Lambda of < 0.90 equates to a 50% decline in 7 years; 9 sub-populations over 11 time periods had Lambda < 0.9. In Alberta, the mean Lambda of 0.93 for the 11 sub-populations equated to a 57% cumulative decline from 1994-2012.

The present and future trend in the BP can also be inferred from a recent assessment of population size, size of range, and disturbance levels. The Federal Recovery Strategy (Environment Canada 2012) identified 51 local populations (see **Designatable Units** section) and assessed the likelihood of 50 ranges to maintain Boreal Caribou (1 range [SK1] in northern Saskatchewan was omitted from assessment because it is a unique situation and lacked critical habitat analysis; Environment Canada 2012). A self-sustaining local population is a local population of Boreal Caribou that on average demonstrates stable or positive population growth over the short-term (≤20 years), and is large enough (minimum of 10 females) to withstand stochastic events and persist over the long-term (≥50 years), without the need for ongoing active management intervention (Environment Canada 2012). A total of 14 local populations were predicted to be 'self-sustaining' (65% of entire range), while 26 (13% of entire range) were 'likely not self-sustaining', and 10 (22% of entire range) are 'as likely as not self-sustaining' (Table 2). The classification of 'as likely as not self-sustaining' indicates uncertainty about the viability of the population; because of this uncertainty such ranges are not considered as part of the contribution towards population objectives in the National Recovery Strategy, and are labelled as 'not self-sustaining' in the Strategy (Environment Canada 2012). Population estimates are available for 40 local populations, usually expressed as a minimum and maximum estimate. Most (69% of maximum population size estimate) of the known Caribou population was predicted to exist in 9 self-sustaining local populations, while most of the local populations (25; 13% of the total population) were not self-sustaining, and 6 local populations (14% of total population) were classified as likely as not self-sustaining. The 'likely as not' ranges exceed the disturbance management threshold of >35% disturbance (Figure 10) and based on the precautionary principle are considered in this assessment to likely experience population declines. These ranges are combined with the 'likely not self-sustaining ranges' for a total estimate of amount of area and population in decline. Therefore, 35% of the BP range area, and 27% of the population are inferred to be in decline. The proportion may be higher; a 2014 fire event burned 3 million hectares in NT and there is concern that the range is not as self-sustaining as it is presently assessed (Boyan and Carrière pers. comm. 2014).

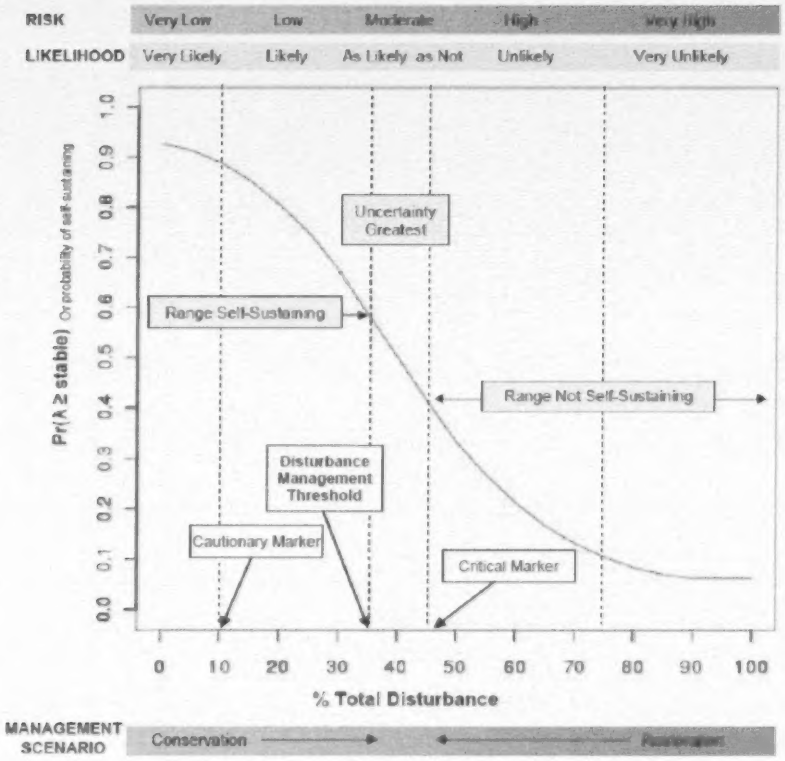

Figure 10. Relationship between the amount of disturbance and the probability of a Caribou population in the Boreal population designatable unit being self-sustaining. The probability of observing stable or positive growth ($\lambda \geq 1$ = stable) of Boreal Caribou local populations over a 20-year period at varying levels of total range disturbance (fires ≤ 40 years + anthropogenic disturbances buffered by 500 m). Certainty of outcome, ecological risk, and management scenarios are illustrated along a continuum of conditions. Source: Environment Canada (2011).

Based on the National Recovery Strategy, Lambda values, and recent population updates, ranges in most jurisdictions along the southern portion of the DU are in population and habitat decline, such as Alberta (all 9 ranges, monitored from 2001-2011), Manitoba (1 range, 2005-2009), Ontario (7 ranges, 2009-2013), Québec (3 ranges, 2002-2012), and Labrador (2 ranges, 2002-2012) (Table 2, 5). A more recent assessment of BP range in Ontario (OMNR 2014), suggests that only 2 of 13 ranges (15% of total BP area, and 19% of minimum population count, in Ontario) have Lambda > 1.0, a decrease of 3 ranges and 105,784 km^2, or 7% of the 65% of total BP range that is defined as self-sustaining in the National Recovery Strategy (Environment Canada 2012). A similar issue may apply to Quebec; research on three sub-populations in a large area (~ 112,000 km^2) southeast of James Bay indicates population decline even when disturbance levels are at the 35% maximum threshold (Rudolph *et al.* 2012).

In summary, approximately 1/3 of the area and population of BP Caribou are in decline, based on recorded declines, negative Lambda for most sub-populations, and the percentage of ranges that have too much disturbance to be self-sufficient. Lambda rates indicate declines of up to 50% are likely to continue in the most affected areas, and lesser declines will occur in sub-populations with negative Lambda. An ongoing decline of > 30% is inferred.

Rescue Effect

As per COSEWIC guidelines, rescue effect can only occur within a DU; rescue of one DU by another DU is not supported for purposes of status assessment. All three DUs are endemic to Canada, therefore rescue of outside populations within the same DU is not possible. Rescue of isolated ranges within a DU is possible but these events relate to recovery, rather than status, and are not discussed in this report.

THREATS AND LIMITING FACTORS

Boreal Population

Threats of high concern identified in the National Recovery Strategy (Environment Canada 2012) for BP are habitat alteration from anthropogenic disturbance, and predation. Threats of medium concern are habitat alteration from fire, climate change that increases fire, hunting, and noise disturbance. Jurisdictions with recovery plans typically identify the same threats (e.g., BC Ministry of the Environment 2010; Labrador (Schmelzer *et al.* 2004), Manitoba (MBWCMC 2014). Some threats interact and can have cumulative impacts that may not be evident when threats are examined individually (Weclaw and Hudson, 2004; Boreal Caribou ATK Reports, 2010-2011; Badiou *et al.*, 2011; Environment Canada 2012).

The National Recovery Strategy for the BP identifies a disturbance management threshold of 65% undisturbed habitat in a range as a measurable probability (60%) for a local population to be self-sustaining. A population of 100 animals provides a 0.7 probability of not reaching a quasi-extinction threshold of less than 10 reproductively active females under stable conditions (Environment Canada 2011; Figure 10). The 65% threshold is considered a minimum threshold because at 65% undisturbed habitat, there remains a significant risk (40%) that a local population will not be self-sustaining (*i.e.*, < 10 breeding females) (Environment Canada 2012). The definition of disturbed habitat is the presence of fire < 40 years old and or anthropogenic disturbance visible on Landsat at a scale of 1:50,000, including habitat within a 500 m buffer of the anthropogenic disturbance (Environment Canada 2012). Figure 11 uses BP range in Ontario to illustrate the extent of disturbance when both anthropogenic and natural disturbances are mapped, following the methodology in Environment Canada (2012).

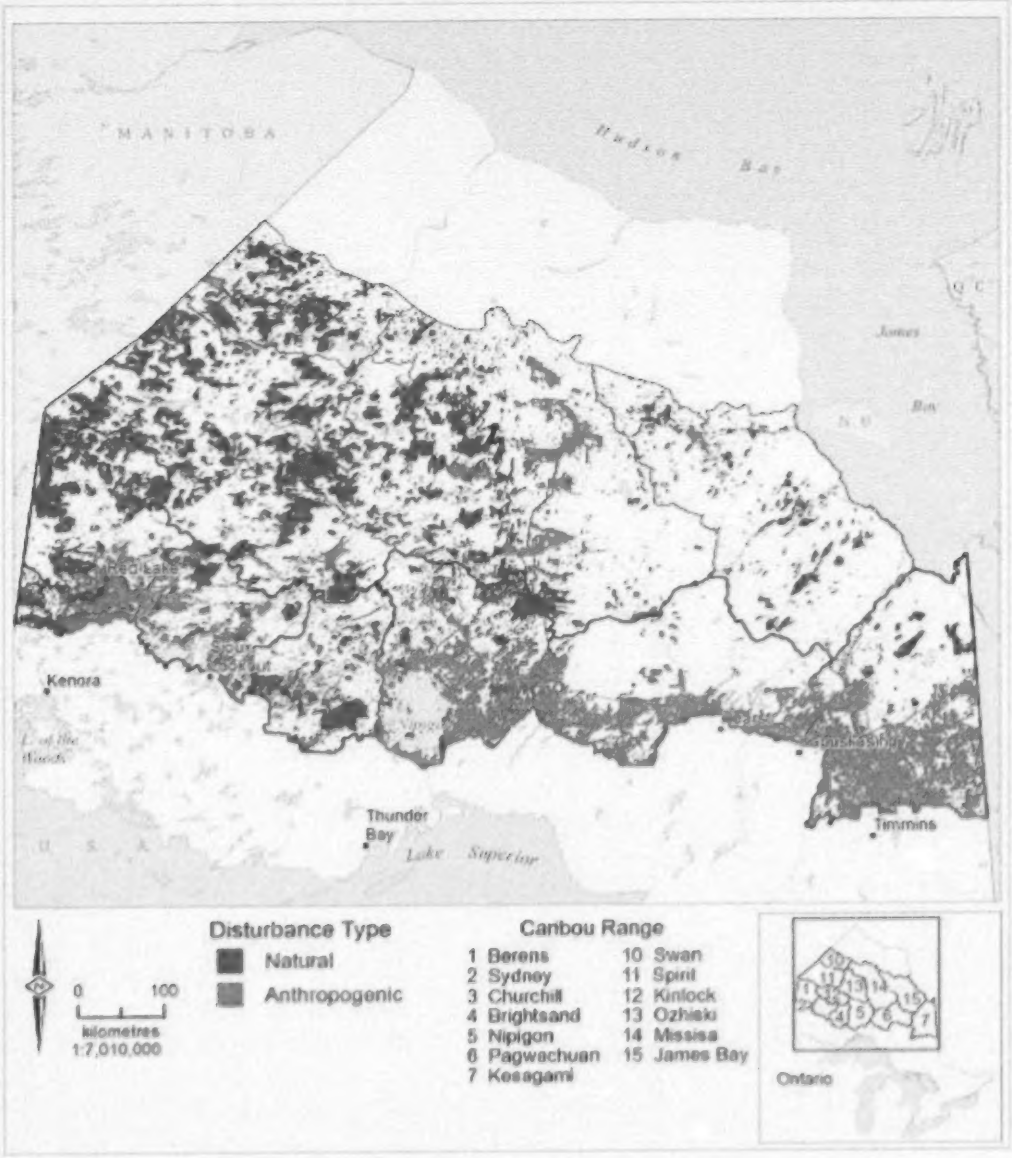

Figure 11. An example of the extent of disturbance in Boreal Caribou range. Map shows forest cover < 36 years of age caused by natural (*i.e.*, fire, blowdown) and anthropogenic (*i.e.*, resource extraction, roads) disturbance in continuous Boreal Caribou range, Ontario. Anthropogenic disturbances include a 500 m buffer. When anthropogenic disturbances overlap with natural disturbances it is counted as anthropogenic. Source: OMNR (2014).

Sorensen *et al.* (2008) identified a strong negative relationship between recruitment rate of Caribou in Alberta and the level of disturbance from both anthropogenic and natural origin. Sleep and Loehle (2010) questioned the simplicity of these models and suggested that they overestimated Caribou population growth rate and possessed low predictive power. The Science Review for the Identification of Critical Habitat conducted by Environment Canada (2008) extended Sorensen *et al.*'s (2008) study. This meta-analysis was further improved by Environment Canada (2011) and their best model (*i.e.*, fire + 500 m buffered anthropogenic disturbance, exclusion of reservoirs) explained 69% of the variation in calf recruitment across a sample of 24 Caribou ranges based on the percent total disturbance in each range. The Hervieux *et al.* (2013) method, which was based on known survival rates of females and calves (see Sampling Effort and Methods section), came to the same conclusion on extent of declines as the method used in the National Recovery Strategy, suggesting there is value in the disturbance threshold method of Environment Canada (2011, 2012).

The IUCN Threats calculator for BP indicates an overall threat score of Very High-High (Appendix 1). The High threats were Logging and Predation.

High and High-Medium Threats

Logging and Wood Harvesting (IUCN 5.3)

Loss of mature forest (mainly by harvesting, but also mining, hydroelectric and oil and gas development) is the most pervasive method of habitat alteration in the boreal forest (Gagnon and Morin 2001; McRae *et al.* 2001; Burton *et al.* 2003). ATK states that the BP has altered their diet in response to forestry disturbance and, as a result, their meat has a different taste (McDonald *et al.* 1997; Huntington *et al.* 2005, cited in COSEWIC 2012, p. 65).

The limit of timber harvest is moving northwards to reach unharvested forests, thereby increasing access to other resource development via road construction (Festa-Bianchet *et al.* 2011). Local forestry expansion rates are unknown but declines in Caribou range of 8-36 km/decade correspond to resource development (see Canadian Range section). Industrial forest activity has been expanding northward into BP range. Provincial land planning exercises in the last 20 years (e.g., Ontario Lands for Life; Watton and Dunn 2003) and auctioning of large areas (e.g., 68,000 km^2 forest management agreement in northeastern Alberta in 1991; Alpac 2014) have extended industrial forest management northward. Much of the disturbed land identified in the National Recovery Strategy (Environment Canada 2012) corresponds with the location of the new forestry licences. In Labrador, forest harvest operations as of 2004 were restricted to a small portion of the Red Wine Mountain range but further harvest has been proposed within the range (Schmelzer *et al.* 2004).

The northward extension of large-scale industrial forestry is limited by provincial government forest licence planning restrictions (Greenpeace 2014). However, industrial forestry has not yet reached these northern limits (Figure 12) and impacts of forestry on Caribou are projected into the future. The long-term (*i.e.*, 25-year) leases require companies to practise sustained yield harvest; areas harvested will eventually be re-harvested, concurrent with maintained access roads. In Quebec, Leblond *et al.* (2014), using an expert-based habitat suitability model, showed that very few suitable habitats are still available for caribou below the northern limit of commercial forestry.

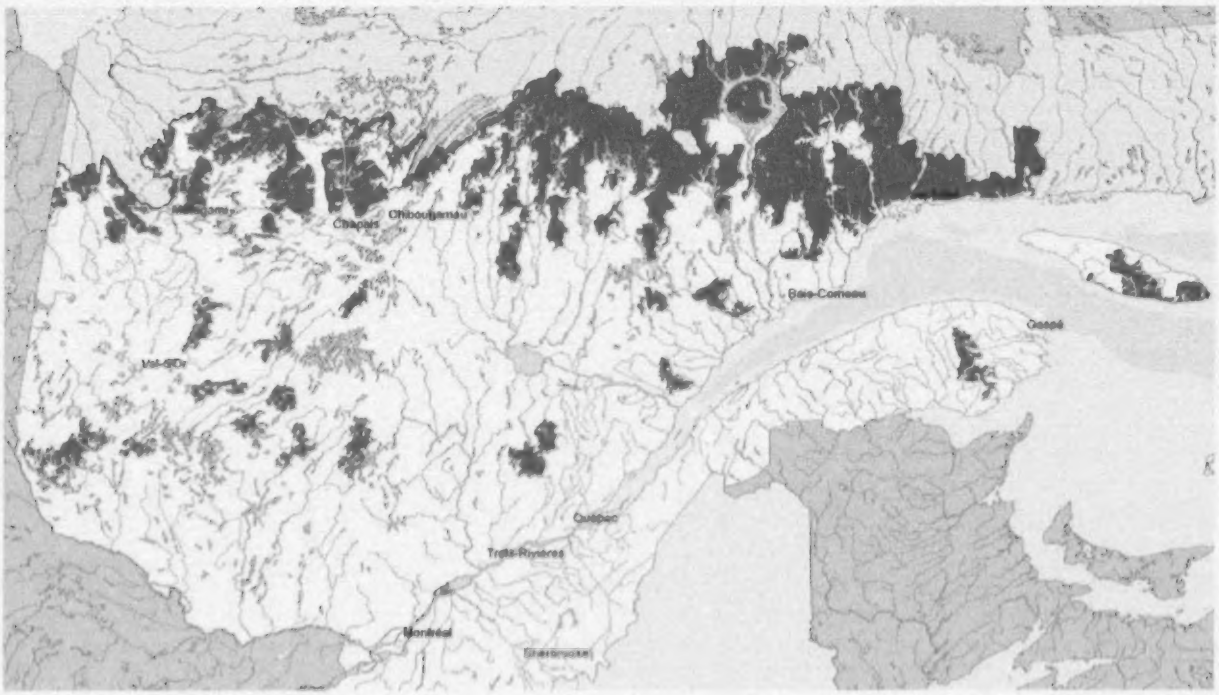

Figure 12. Location of northern limit of industrial forestry in Quebec and remaining forest land existing in large blocks of > 500 km^2 (green), as of 2009. Source: Greenpeace (2010).

Caribou appear to be sensitive to noise from snowmobiles, motorized boats, vehicles, and aircraft (e.g., low-level flight training in Labrador, Schmelzer *et al.* 2004), which may increase chronic stress. Renaud (2012) recorded higher cortisol levels in Caribou with higher percentage of clear-cut harvest in their range compared to Caribou in undisturbed habitats. Caribou have been shown to flee from areas with noise disturbance from these sources (COSEWIC 2012). SRRB (2010) reported that noises, including industrial noises, may represent a threat to Caribou:

"Noise is given as a major factor that impacts boreal woodland caribou. These disturbances include drilling, seismic cut-line activities, slashing, and machines including helicopters and all-terrain vehicles that conduct work during the summer. Caribou prefer old growth areas and have a tendency to stay away from winter roads because of noise pollution."

In Labrador, the Red Wine Mountain sub-population was exposed to low-level military jet training in the 1990s-2000s, which was associated with changes in movement patterns (Harrington and Veitch 1991; 1992) and lower calf survival (Harrington and Veitch 1992). Some Aboriginal experts reported to COSEWIC (2012) that Caribou were more likely to be initially frightened by industrial or vehicular noises but eventually habituated over time.

Problematic Native Species (IUCN 8.2) - predation

Caribou declines have been associated with increased predation rates, which are associated with anthropogenic disturbance (see **Habitat Trends** section). Leblond *et al.* (2013b) showed that the probability of an adult Caribou dying from predation increased with the proportion of recent disturbances in their annual home range. Changing predator-prey dynamics are associated with density of alternate prey species increasing after forest clearing (*i.e.*, apparent competition; see **Habitat Trends** section). Although predation is a natural process, predation rates appear to be unsustainable in disturbed parts of the BP range.

Increased predation rates via apparent competition are widely accepted as the primary driver of BP decline across disturbed parts of their range (e.g., Cumming *et al.* 1996; Rettie and Messier 2000; James *et al.* 2004; Courbin *et al.* 2009; Whittington *et al.* 2011) although alternative hypotheses are being studied (see Change in Predation Rates section).

Apparent competition within the BP range typically involves Wolves as the primary predator and Moose as the alternative prey species, although White-tailed Deer constitute alternative prey species in some regions (e.g., Alberta; Latham *et al.* 2011b). Black Bear also are an important predator; Leclerc *et al.* (2014) recorded that Black Bear depredation accounted for 52% of Caribou calf deaths in the Charlevoix and Saguenay region of Quebec. In areas with a large industrial footprint, Nagy (2011) suggested that aggressive management actions, including predator control, may be required to provide secure habitat for Caribou. In Alberta, 733 Wolves in the Little Smoky Caribou range were culled from 2005 to 2012 to help with Caribou recovery. Predator control in this area is ongoing (Smith and Pittaway 2011; Hervieux pers. comm.) but has not resulted in population increase, suggesting habitat management also is necessary (Hervieux *et al.* 2014).

Medium – Low Threats

Energy Production and Mining (IUCN 3)

Few studies have examined the effects of mining operations on Caribou. Information from the migratory Bathurst sub-population (DU 3) in the NT may be relevant. In this study, the combination of direct (*i.e.*, physical footprint) and indirect (*i.e.*, noise, dust, and other sensory disturbances) effects created a ZOI around a mine site that can change the behaviour and occurrence of the animals. Studies in the vicinity of two diamond mines north of Yellowknife in the NT showed that migratory Caribou occurrence decreased with increasing proximity to the mine (Boulanger *et al.* 2012). Studying the same migratory Caribou sub-population, Johnson *et al.* (2005) reported that habitat quality was most severely reduced during the post-calving season; modelled coefficients effected a 37% reduction in high-quality habitats, and an 84% increase in low-quality habitats.

Wilson *et al.* (2010) modelled management actions with different scenarios for the next 50 years that could mitigate the impacts of petroleum and natural gas (PNG) development on the BP in British Columbia. In the scenario simulating no further PNG exploration and development (*i.e.*, equivalent to a moratorium on future PNG industry), the estimated Caribou population would be approximately stable at 1300 animals although two local ranges (out of six) could be extirpated. In the scenario wherein only committed PNG tenures (*i.e.*, accepting no new tenures for the future) were allowed to proceed, the BC sub-population would be about 800 animals in 50 years, and three local ranges would have high probability (>40%) of extirpation. The third scenario modelled a situation wherein no deferrals or management actions were implemented (*i.e.*, PNG development continued to increase as in recent years). In this scenario, the BP would contain 250 Caribou and there is a very high probability (>60%) that they would be extirpated from all but one range (Maxhamish range).

Although also present in BC and Saskatchewan, petroleum and natural gas (PNG) infrastructures are more frequent in Alberta, where some form of PNG activities is present in nearly all remaining Caribou ranges. In Alberta, PNG infrastructures and forest harvest are frequently conducted in close proximity to one another; the resulting degree of disturbance in Caribou habitat is often significant, as in the Little Smoky Caribou sub-population range, which is 95% disturbed and at immediate risk of extirpation (Schneider *et al.* 2010).

As of 2008, there were 105 active mines in the Boreal Forest, covering 44% of all mines in Canada, and an area of 583,000 km^2 (BorealCanada 2008). In Quebec, for example, expenditures for mining exploration and appraisal were approximately $200 million in 2003, and > $800 million in 2011 and 2012 (Government of Quebec 2014). Predicting the location and extent of future mining activity is difficult because development of new mines is strongly dependent on the changing market value of minerals. Mining claims indicate potential development, rather than a confirmed threat. Figure 13 illustrates potential location of mining relative to Caribou distribution and protected areas in Canada.

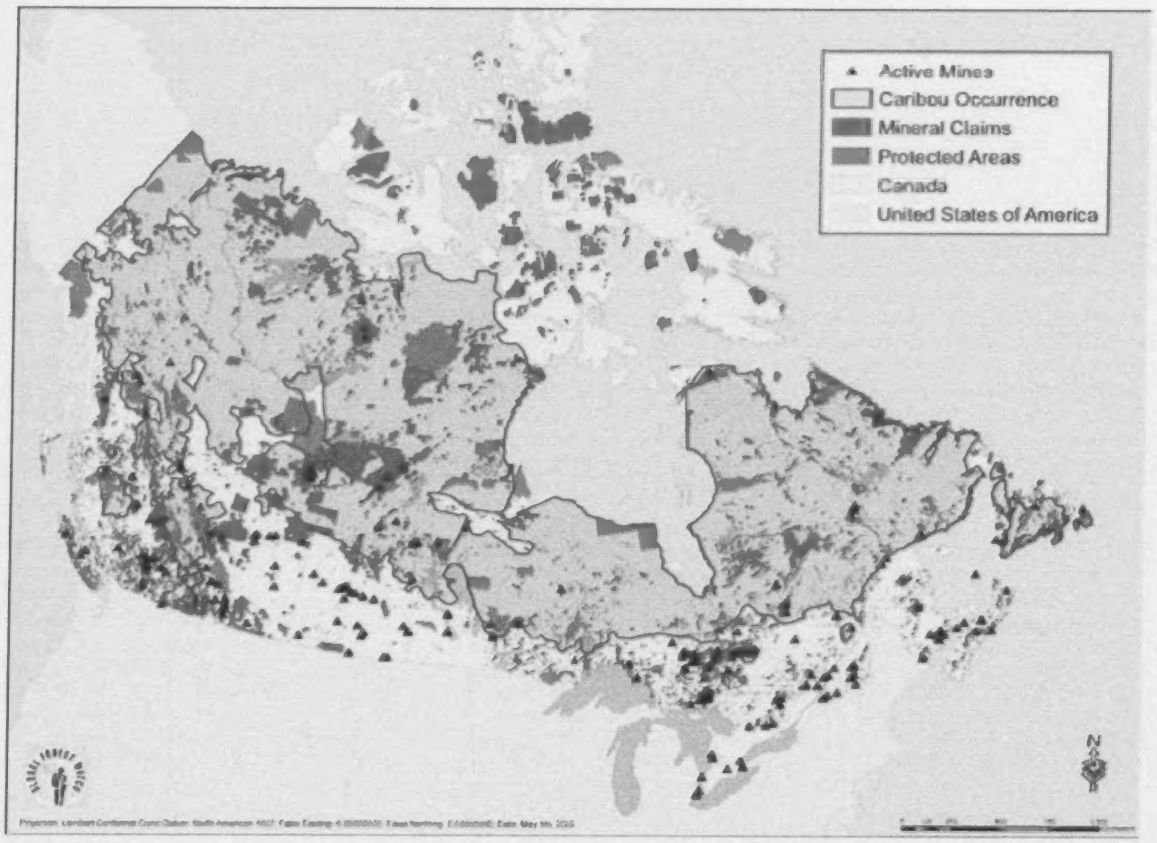

Figure 13. Location of mineral claims, protected areas, and Caribou in Canada, as of 2008. Source: BorealCanada (2008).

In BP range on Tłı̨chǫ territory in NT, a proposed nickel copper mine will result in the south NT range (Environment Canada 2011) exceeding the 65% disturbance threshold for sustainability. Most previous disturbance had been related to fire (MVRB 2013). In the Sahtu Settlement Area in the NT, an ATK process noted that many changes are occurring that could impact Boreal Caribou and cited climate change and industrial activities as causes for concern SRRB (2010).

Peat mining is a growing industry in northern Alberta and Saskatchewan, with numerous proposals and permit applications ongoing. The removal of peat would represent a loss of habitat, as well as a source of road and infrastructure development.

Hydroelectric projects may result in habitat loss due to flooding, infrastructure and linear features. For example, the Red Wine Mountain sub-population in Labrador occurs in the Lower Churchill Falls project, which will flood 126 km^2 of forest, create 345 km of temporary roads for the estimated 10-year construction period and 30 km of permanent roads connecting to the Trans-Labrador Highway, as well as 263 km of transmission lines (Nalcor 2013). Habitat suitability analysis using a ZOI (see Habitat Avoidance section) of 2-4 km width suggested a cumulative impact to 16% of primary calving range, and 22% of primary winter range (Nalcor date unknown). Numerous hydroelectric projects are proposed; for example, in Ontario, 10 facilities are planned for the region west of James Bay in the next 15 years (Carlson and Chetkiewicz 2013).

Linear Features (Roads, utility lines; IUCN 4.1, 4.2)

Direct mortality as roadkill is not a significant threat from roads. Linear features, such as roads and seismic lines, represent both functional habitat loss because Caribou appear to avoid them, and predation risk because mortality is increased (see Habitat Avoidance section). Building of new roads during industrial development provides access to people using trucks, snowmobiles, or ATV to a new territory, which represents an additional source of disturbance and increased hunter presence in Caribou range where hunting is permitted.

Projected road density is unknown over the large BP range. Many roads are associated with mining development but specific projects are dependent on economic factors and the certainty of projects is difficult to predict. However, there is expected growth in mining and forestry activities throughout much of BP range and it is likely that road density will increase. In Manitoba, for example, construction is underway on a 1000 km, all-season road network to connect remote communities in the region east of Lake Winnipeg, and there are proposals for connecting many northern Manitoba communities (Government of Manitoba 2014). Another indication of potential disturbance in BP range is the 2011 (renewed in 2014) Plan Nord, an $80 billion proposal for investment in roads, airports, mining, and forestry in central and northern Quebec (Northern Miner 2014). In 2014, $63 million was budgeted to extend access along the north shore of the St. Lawrence (Highway 138) and repair Highway 389 in the Côte-Nord region (Baie-Comeau to Labrador) and the James Bay Highway (Matagami to Radisson) (Resource Clips 2014).

Hunting (IUCN 5.1)

In the NT, evidence suggests that the current harvest of the BP is relatively low because most Aboriginal communities rely primarily on Barren-ground Caribou (DU3), or Moose for sustenance. Aboriginal harvest rates are not believed to be significant in NT (NT Species at Risk Committee 2012). Sport hunting of Boreal Caribou has been banned across the range, first in Ontario (in 1929), then other provinces in the last 20 years; Alberta (1985), Saskatchewan (1987), BC (2001), Manitoba (2006), NT (Festa-Bianchet *et al.* 2011). In Québec, sport hunting in Zone 19 (north shore Québec to Labrador) took an average of 56 Caribou annually between 1980 and 2000. This hunt was permanently closed in 2001 and, since then, no sport harvests have directly targeted Boreal Caribou in Québec. However, harvest of migratory Caribou (DU4) is ongoing and the two DUs overlap

in some areas for parts of the year. In Labrador, sport hunting was closed in 1986 or earlier, while subsistence hunting was closed in 2002 following listing of Boreal Caribou under the *Endangered Species Act*.

Illegal and accidental harvest of Boreal Caribou may occur where their range overlaps with the range of migratory Caribou that are hunted in Saskatchewan, Ontario (native hunt only), Québec, and Labrador (Schmelzer *et al.* 2004; Courtois *et al.* 2007, Comité de rétablissement du caribou forestier 2007). Subsistence hunting, while closed, continues to occur in Labrador where mortality from hunting represented 29% and 11% of all known mortalities of collared Caribou for Lac Joseph and Red Wine Mountain sub-populations, respectively, between 1997 to 2009 (Schmelzer 2013). In April 2003, 15% of the total Red Wine Mountain sub-population were poached in one incident (Schmelzer *et al.* 2004). Mortality estimates from poaching of Boreal Caribou are unknown but illegal hunting may be present in some regions. With current declines of large migratory sub-populations in eastern Canada and corresponding hunting closures or reductions, subsistence hunting of Boreal Caribou has increased substantially.

Russell (2011) reported the assessment done by the Labrador Metis:

> *"The top three threats to boreal woodland caribou in Labrador include: illegal hunting, technology and predation. Concerns regarding overhunting were primarily concerning Innu hunters from Québec and observations of hunting using spotlights and aircraft spotting of animals for hunters....Modern vehicles (skidoos, trucks, planes, satellite tracking & GPS) are thought to provide easier access to caribou for hunting than traditionally used methods by foot or dog team. Generally people are less respectful to caribou than in the past and kill as many as they want without fully utilizing the animal."*

Aboriginal people have unique harvesting rights for fish and wildlife under Canadian constitutional law. However, these harvest rights may be altered by land claim agreements where conservation goals must take precedence (e.g., Labrador Inuit) and some communities agreed to stop or limit their harvest of Caribou. Aboriginal harvests remain a source of mortality for many Boreal Caribou populations but there is little information on its extent or impact (Hayes *et al.* 2003; Courtois *et al.* 2007), because reporting is limited. Action 4b of the 2012-2023 Quebéc Caribou Recovery Plan identifies the need to identify harvest management terms and conditions between Aboriginal communities and the provincial government. In the James Bay region of Québec, Rudolph *et al.* (2012) demonstrated that Aboriginal hunting had a significant negative impact on Boreal Caribou. Schmelzer *et al.* (2004) reached the same conclusion in Labrador. Hunting of boreal caribou is facilitated by construction of roads and other linear features and by use of off-road vehicles that permit access to previously inaccessible areas.

In conclusion, although the extent of hunting is poorly described in some regions of the BP range across Canada, many observations indicate that it remains an important component of Caribou mortality and hence may represent a threat to some local populations (Callaghan *et al.* 2011), such as in Alberta (Dzus 2001) and Labrador (Schmelzer *et al.* 2004).

Low Threats

Fire and Fire Suppression (IUCN 7.1)

Many native elders note that lands are now drier, which has increased the frequency and severity of forest fires, and has reduced the winter range available for Caribou (Northern River Basins Study 1996 quoted in COSEWIC 2012, p. 99).

> *"Recent changes in climate are significant which include warmer temperatures, increased rain in November, milder winters and increasing summer storms. Boreal woodland caribou food sources are affected by precipitation. During colder times, food becomes less accessible as it is covered by more snow, making it harder for caribou to access."* (SRRB (2010), in COSEWIC (2012, p. 100).

Caribou co-evolved with forest fires, which are a natural component of the boreal forest, but the effect of fires on Caribou range occupancy is complex and subject to conflicting reports in the literature (Schaefer and Pruitt 1991). Forest fires initially diminish the forest habitats of Caribou because they result in loss of mature conifer stands, loss of lichens and other forage plants, and act as barriers to movement (Thomas and Gray 2002; Dalerum *et al.* 2007; Dzus *et al.* 2010; Environment Canada 2012). Caribou generally do not return to burned areas for several decades until the forest is old enough to support lichens and other food sources, although they may make limited use of burned areas to feed on new growth (Boreal Caribou ATK Reports 2010-2011; CRA 2010).

Fire can also be beneficial because it helps generate coniferous trees (*i.e.*, Jack Pine, *Pinus banksiana*) and prevent replacement of lichens by inedible feather mosses (Hypnaceae) in mature or old forest (Schaefer and Pruitt 1991). Fires reduce lichen biomass but may increase the amount of summer green forage (Fisher and Wilkinson 2005). Elders of the Anishinaabe Nation state that Caribou will use habitats affected by forest fires only once the vegetation regrowth begins (Miller 2010). Although fires initially decrease Caribou habitat, balancing the short-term detriments of fire against the long-term benefits is the key to the understanding of the effects of fire on Caribou (Schaefer and Pruitt 1991). Caribou shift their use of habitat from the burned areas to areas that are more suitable (Environment Canada 2011). However, suitable new areas may be limited in areas with fire and increased forest harvest and disturbance. As a result, forest fires can threaten Boreal Caribou recovery, even though they are a natural component of the boreal forest ecosystem (Environment Canada 2012).

The fire cycle follows a gradient from west to east where it is shorter in western Canada than in eastern Canada (Bergeron *et al.* 2001). In the eastern provinces, the fire rotation is about 111-139 years in western and central Québec's Black Spruce (*Picea mariana*) forests on xeric soils, but increases to about 500 years in eastern Québec and southeastern Labrador's mesic Black Spruce forests (Bergeron *et al.* 2001; Bergeron and Le Goff 2005). The Boreal Caribou ranges in Saskatchewan are particularly affected by forest fires and the Boreal Shield range fire rotation can be about 70 years. Figure 11 displays the extent of fire within Caribou range in Ontario. At the other extreme in fire rotation, fires have not played a major role in the regional forests around the GP in recent history (1952-1998), the fire cycle being currently estimated at more than 2,700 years (Parisien *et al.* 2004). In summer 2014, an unprecedented 3 million hectares of Caribou habitat was burned (Carriere pers. comm. 2014).

An increase in fire periodicity above natural intervals could reduce lichen-bearing forests. The regeneration time of lichen after burns will influence the length of time before sites become suitable again; in forests of the NT near the Saskatchewan border, 'caribou lichen' (*Cladina* spp, *Cetraria nivalis*) biomass stabilized between 40-60 years (Thomas *et al.* 1995). Predictions for future fire impact vary from a 1.9X increase in area burned in western mixed boreal forest (Krawchuk *et al.* 2009), to significant increase in fire severity in parts of central and western Ontario (Colombo *et al.* 1998), a 7X increase in BP range in central Quebec (Le Goff *et al.* 2009), to a minor impact in eastern boreal forest (Bergeron *et al.* 2001). Modelling based on a scenario of 3X CO_2 increase suggests that, compared to fires between 1959-97, there will be an approximately 50% increase in fire over the BP range by 2100 (Flannigan *et al.* 2005).

Unknown Threats

Recreational Activities (IUCN 6.1)

Recreational activities, such as snowmobiling, hiking, skiing and cabins can have significant impact on Caribou by displacing them, forcing them to use lower quality habitats, or changing their behaviour (Duchesne *et al.* 2000; Mahant 2013). Each of these responses can impact body condition, recruitment, individual survival, and vulnerability to predation (Bergerud 1988; Vistnes and Nelleman 2008; Bowman *et al.* 2010).

Problematic Native Species (IUCN 8.2) – parasites and pathogens

Caribou parasites can influence host population dynamics, and quality and safety of the meat consumed by people (Kutz *et al.* 2009). Potential changes in the distribution of alternative prey species could have negative consequences for the BP. The presence of abundant Deer is considered one of the factors in Caribou range recession, as a food item for Wolves and vector for disease (Dumont and Crête 1996; Racey and Armstrong 2000; Pitt and Jordan 2004). Meningeal Brainworm (*Parelaphostrongylus tenuis*), which is non-lethal to White-tailed Deer, can be transmitted via gastropods on vegetation to Caribou and causes death (Anderson and Strelive 1968). *P. tenuis* exists from Saskatchewan eastward (Wasel *et al.* 2003). Re-introduction attempts into historical southern range have failed, likely because of the establishment of infected Deer populations (Bergerud and Mercer 1989). In Maine, for example, 32 Caribou (originally from stock from Newfoundland) were released in 1989; of 25 known mortalities, 26% died from Brainworm (McCullough and Connery 1991).

The historical northward expansion of White-tailed Deer into Caribou range was in response to widespread creation of younger forest and associated preferred browse species (Hall 1987). The northern limit of deer range is limited by severe winters (Hall 1987) and it is likely that deer populations will expand northward into Caribou range because of climate change (Thompson *et al.* 1998; Pickles *et al.* 2013). White-tailed Deer have expanded into boreal forest due to warmer winters (Côte *et al.* 2004; Dawe 2011), including a 17.5X increase within BP Caribou range of northeastern Alberta since the 1990s (Latham *et al.* 2011b). *Parelaphostrongylus tenuis* presently is absent in deer in Alberta.

Although Moose can be severely affected by the Winter Tick (*Dermacenter albipictus*), Caribou are also a host of this parasite (Samuel 2004). Kutz *et al.* (2009) reported that Winter Tick range is expanding into the Canadian North (Girard pers. comm. 2014; Larter and Allaire 2014), possibly due to warmer spring weather (Drew and Samuel 1986). In BC, Culling and Culling (2013) observed an increasing number of Caribou with hair loss and patches of bald skin caused by adult Winter Ticks.

Chronic wasting disease (CWD) may spread to Caribou in western Canada with increasing range overlap with Deer and Elk. This prion disease is highly transmissible and it has been detected in 18 states in USA, and in Saskatchewan and Alberta (Tapscott 2011). A recent experimental study confirmed that reindeer are susceptible to CWD by oral inoculation, implicating the potential for transmission to other *Rangifer* subspecies (Mitchell *et al.* 2012).

In 2013, unexpected high levels of Caribou mortality were recorded in northeastern BC, which may have been due to an outbreak of *Erysipelothrix rhusiopathiae* (Macbeth *et al.* 2014). This is the first record this pathogenic bacterium in North American Caribou, but it is implicated in mortality events in Musk-ox (Kutz pers. comm.).

Habitat Shifting (IUCN 11.1)

The Dehcho region is warmer and wetter, which results in ice formation over ground lichens preventing successful foraging. Winter thaws create ice, which reduces available Caribou forage and increases the energy used by Caribou to obtain forage (COSEWIC 2012, p. 99). There is growing concern that large areas of boreal peatland are converting from forest to wetlands. Permafrost covers 37% of boreal peatland across BP range, and is melting due to climate warming; 9% loss was recorded in one study (Baltzer *et al.* 2014) in the last 40 years, with the rate tripling since 2000. Compared to forest, the wetlands may become relatively unused habitat.

Pollution (IUCN 9.2, 9.5)

Aboriginal users of Caribou have raised concerns that pollution and other environmental contaminants are negatively affecting this species (COSEWIC 2012). However, studies that assessed contaminant levels in Caribou tissues have not suggested that these pose a risk to Caribou survival (for example in the Yukon, see Gamberg 2004).

Gaspésie Population

Using metrics from the National Recovery Strategy for the BP (Environment Canada 2011) of a 500-m buffer zone on clear-cuts and roads, and no buffer on fire and windthrow areas, St-Laurent (unpub. data) determined that the disturbance level of the GP area as 75% (Figure 14), well above the 35% threshold determined necessary for sustainability for the BP (Environment Canada 2011). The disturbance was mainly from roads, and forest harvest. The National Recovery Strategy framework likely applies to the GP because the response of the GP to forest change, linear features, and predators is similar to responses recorded by the BP (see **Habitat Trends** section).

The IUCN Threats calculator for GP indicates an overall threat score of Very High – Very High (Appendix 2). The High threats were Logging and Predation.

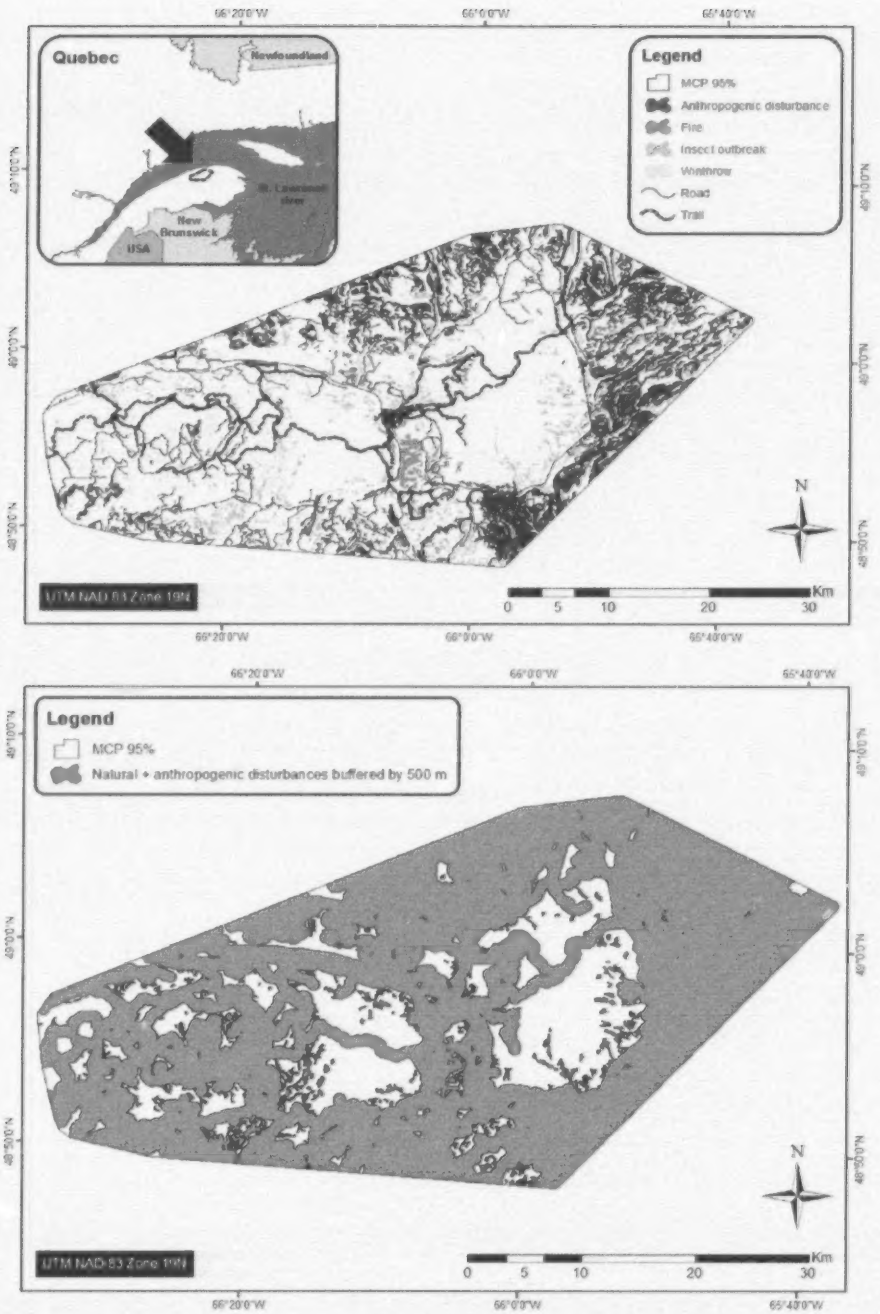

Figure 14. Extent of anthropogenic disturbance within the Gaspésie population designatable unit, based on methodology used in Environment Canada (2012). Source: St-Laurent unpub. data.

Very High Threats

Renewable Energy (IUCN 3.3)

Wind turbine farms exist within GP range and three more farms are in development, with turbines close enough that most of the intervening forest likely will be removed (Lalonde pers. comm.).

Logging and Wood Harvesting (IUCN 5.3)

Logging within the Park from 30 years ago, and in GP range more recently, has created young forest that is generally poor Caribou habitat. Specialized forestry practices are applied to most of the GP range (see **Habitat Protection and Ownership** section), with the goal of maintaining lichen availability and connectivity, but also minimizing creation of habitat that could increase predator density. Roads and harvest contribute to a disturbance level of approximately 75% (M.-H. St-Laurent, unpub. data) in the greater GP areas. Future trends in forestry activity are unknown.

Problematic Native Species (IUCN 8.2) - predation

Extinction is predicted in 20 years if calf mortality remains at present rates (Lesmerises 2012; see **Fluctuations and Trends** section). A study of 25 radio-collared calves in 1989 and 1990 identified Coyote predation as causing 64% of calf deaths, while Black Bears and Golden Eagles caused 27%, and 4%, respectively (Crête and Desrosiers 1995). Low calf survival in the GP is attributed to predation (St-Laurent *et al.* 2009) and predator removal programs were put in place from 1990 to 1996 (Pilon 1997) and from 2001 to present. Coyotes and Black Bears were culled at varying intensities and locations (Équipe de rétablissement du caribou de la Gaspésie 2011). Predator control temporarily improved calf recruitment in some years but these trends stopped when predator control ceased (Lalonde 2013).

Apparent competition in the GP is likely a contributing factor to Caribou decline via a complex Coyote, Bear, Moose, Deer and Caribou system evolving in disturbed range. Similar to the BP, timber harvesting in the GP range has created favourable Moose habitat, augmented Coyote populations, and created negative consequences for Caribou (Crête and Desrosiers 1995). Coyote were first sighted in Gaspésie in 1973 (Georges 1976) and by the 1990s, they were the main cause of calf mortality (Fournier and Faubert 2001). Hunting may support predator populations because it provides food to Coyotes and Black Bears via injured animals and carcasses dumped at the edge of the Chic-Chocs and Matane wildlife reserves (Boisjoly 2007; Mosnier *et al.* 2008a; Boisjoly *et al.* 2010). Forestry-mediated habitat alteration fosters populations of Coyotes and Black Bears around the Gaspésie Park as logging modifies those landscapes once dominated by old forest. Black Bears selected clear-cuts in summer and autumn (Mosnier *et al.* 2008b). These regenerating stands also support higher Snowshoe Hare densities, which are an important prey species for the Coyote in Gaspésie (St-Laurent *et al.* 2009). Moose and White-tailed Deer populations have also increased in the Gaspésie region over the last decade (Lamoureux *et al.* 2007), which in turn contributes to increased predator densities.

High Threats

Tourism and Recreation Areas (IUCN 1.3)

Numerous hunting/fishing/outdoor recreation camps and lodges exist in the area, with several proposals for large resorts within the GP range.

Linear Features (Roads, utility lines; IUCN 4.1, 4.2)

The reason for increased use of alpine habitats over time by the GP is unknown but the avoidance of linear structures (paved and unpaved roads, hiking and skiing trails) caused a functional habitat loss of about 30 to 50% (Gaudry 2013), and may have resulted in the greater use of open habitats where there are fewer linear structures.

The abundance of roads is an important factor in the 75% disturbance level for the GP. Future road building or decommissioning activity is unknown.

Medium Threats

Mining and Quarrying (IUCN 3.2)

Mining is not permitted within the area containing most of the GP. There are numerous claims for mining in areas adjacent to the GP (e.g. Mount Lyall, 10 km south) but new mines are not expected in the near future (Lalonde pers. comm.). Hydroelectric facilities are not expected in the area, and there presently is a moratorium on shale gas hydrofracturing in Quebec. A water pumping project is proposed adjacent to the Park, within the range of GP (Lalonde pers. comm.).

Low Threats

Commercial and Industrial areas (IUCN 1.2)

A large water pumping station is in development adjacent to the largest remaining GP sub-population.

Hunting (IUCN 5.1)

Sport hunting of the GP ceased from 1929 to 1934 but subsequently resumed until ceasing definitively in 1949; since then, sport hunting of Caribou has been banned in GP range (St-Laurent *et al.* 2009). With the support of local Aboriginal groups, no subsistence hunting occurs in the GP. Some poaching cases were reported and mortality from any sources could be significant with such a small population.

Recreational Activities (IUCN 6.1)

Winter ecotourism can negatively influence Caribou survival and recruitment because Caribou spend less time resting and foraging, and increase vigilant behaviours in the presence of hikers within the GP (Dumont 1993). There are over 9000 hikers on the Mount Jacques-Cartier within the Gaspésie Park and the presence of these hikers caused Caribou to shift locations from alpine tundra areas to subalpine forests where they were more heavily predated on by Coyotes and Black Bears (Dumont 1993). Hiking trails were recognized as inducing functional habitat loss for Caribou in the Gaspésie National Park (Gaudry 2013) because Coyote and Black Bear use hiking trails to access the high plateaus where Caribou are located, and Caribou are avoiding areas surrounding these trails.

Avalanches (IUCN 10.3)

Parts of the GP range experience avalanches, on the scale of every 2 years. There is the potential for a significant proportion of the remaining animals to be killed in one of these stochastic events.

Unknown Threats

Fire and Fire Suppression (IUCN 7.1)

Comments regarding climate change and the effect of an increase in fires are discussed in the Threats section for the BP. The predicted future fire regime for the Gaspésie peninsula is unknown.

Problematic Native Species (IUCN 8.2) – parasites and pathogens

Near the GP range, the prevalence of Winter Ticks on harvested Moose was high (84-96%) in three hunting areas in 2009 and 2010 while it was absent in 2000 (Gingras 2013); Winter Ticks were found on most GP Caribou during the capture sessions in 2013 and 2014 (M.-H. St-Laurent, unpubl. data). In captivity, Winter Tick infections on Caribou can lead to mortality (Welch *et al.* 1990). Studies are underway to assess *Toxoplasma gondii* and *Neospora caninum* (St-Laurent pers. comm.).

Temperature Extremes/Forage Limitation (IUCN 11.3)

Forage limitation may pose a threat to the GP because Gaspésie Park is essentially an island surrounded by abundant summer forage, but low winter forage, and abundant predators. The GP is dependent on the forested mountain slopes for their winter forage, yet these forests may only be able to support a population of 400 Caribou (Ouellet *et al.* 1996). However, the functional loss of alpine and subalpine habitat associated with the avoidance of linear structure (Gaudry 2013) suggests that this carrying capacity could be overestimated. Forage may thus be sufficient both in quantity and quality, but Caribou may face nutritional restrictions when functional access to forage is limited. Indeed, forage limitation is suspected because pregnancy rates were low in the last two years, especially for young females (M.-H. St-Laurent, unpubl. data). Ice events reduce access to lichen, and are a growing concern because an extensive, extended ice event could impact a larger percentage of the small population (Lalonde pers. com.).

Newfoundland Population

The IUCN Threats calculator for NP indicates an overall threat score of High-Medium, due to cumulative impact of several medium and low threats (Appendix 3). The highest ranked threat was predation (medium threat) and energy production, hunting, logging, recreation, and invasive threats were ranked as low threats. The disturbance threshold used in the National Recovery Strategy framework for assessing sustainability of BP likely applies to the NP at some level but the absence of Wolves, or large fires and intensive forestry over large parts of the range suggests a different threshold of sustainability needs to be determined. In the NP, the human footprint is relatively low and is located mostly in the coastal areas (NL Gov., unpubl. data 2013; Figure 15).

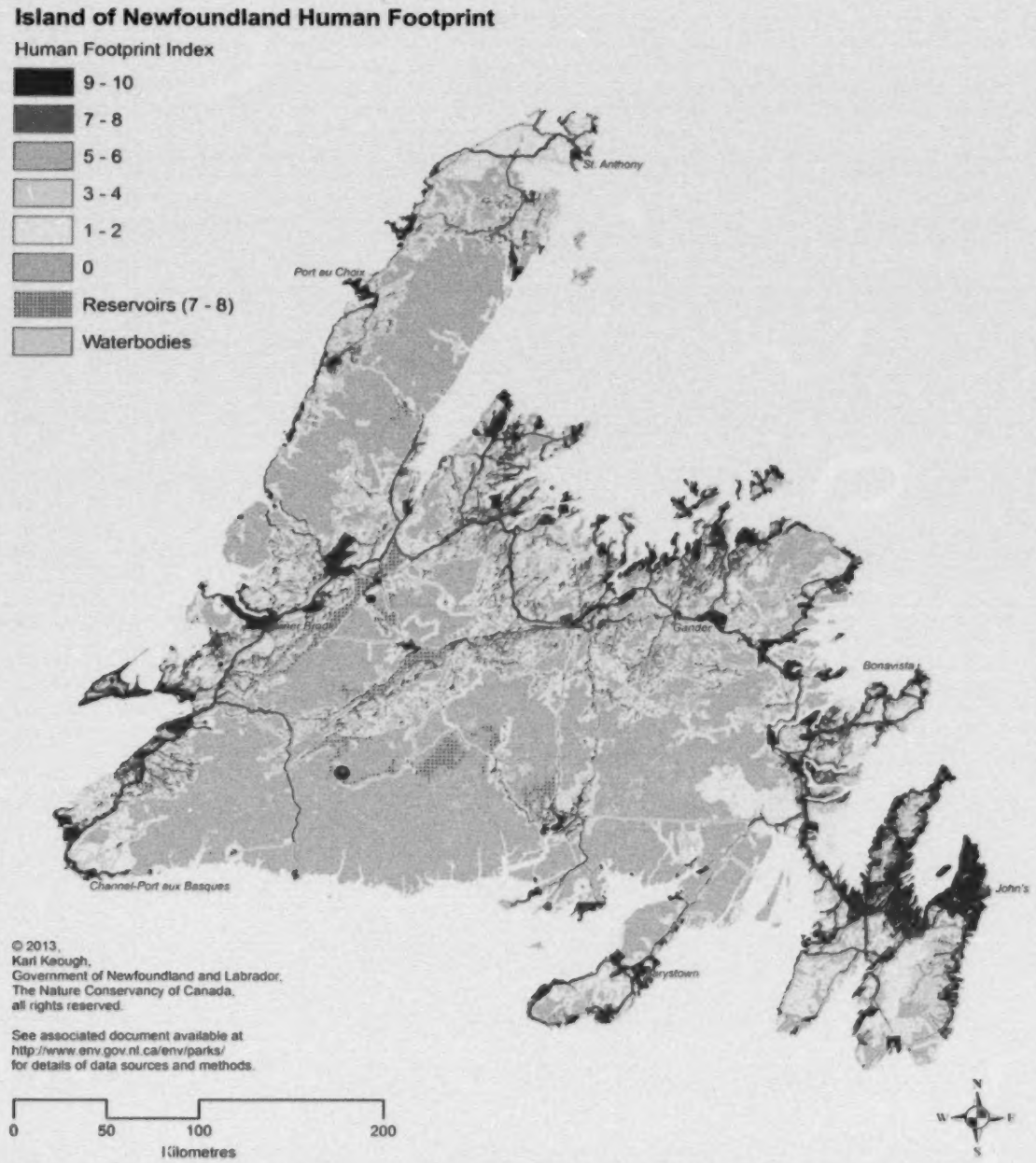

Figure 15. Human footprint in Newfoundland. Source: Newfoundland and Labrador Government, unpubl. data (2013).

Medium Threats

Problematic Native Species (IUCN 8.2) - predation

Black Bear are native to Newfoundland and Coyote are considered naturally invasive because they arrived in 1985 as part of a continental-scale expansion. Predation of calves is an important factor in the population of the NP but the role of predation in the recent decline is less clear (see **Fluctuations and Trends** section). The potential for Wolves establishing in Newfoundland is unknown; there have been two Wolf records since 2009 (Adams *et al.* 2012; Pilgrim *et al.* 2012). If Wolves re-established on Newfoundland, it is likely that predation would become a more significant factor in the NP.

A diversionary food experiment and experimental cull of 40 Coyote over 2 years was conducted in one sub-population, with calf survival rates increasing from approximately 5% before the removal, to 30% afterwards (Lewis *et al.* 2014).

Low Threats

Energy Production and Mining (IUCN 3)

In the NP, the La Poile sub-population showed a general avoidance of a gold mine across all seasons. The avoidance of the gold mine for the La Poile sub-population was most prominent during the pre-calving season and the number, and group size of Caribou decreased with proximity of the mining operation (Weir *et al.* 2007). The ZOI on Caribou varied in size among DUs and ranged from about 4 km to 30 km from a mine site (Weir *et al.* 2007; Boulanger *et al.* 2012). The ZOI appears to be larger for mines with a large geographic footprint and higher levels of activity, and diminished around smaller mines.

Migration patterns can be influenced by anthropogenic disturbance. For example, the timing of migration for the Buchans Plateau sub-population was disrupted by the construction phase of a hydroelectric development but returned to pre-disturbance timing once the construction phase was finished (Mahoney and Schaefer 2002b).

Linear Features (Roads, utility lines; IUCN 4.1, 4.2)

McCarthy *et al.* (2011) found that there was a significant negative relationship between recruitment and the amount of disturbance due to recreation, mining, hydroelectric development, roads, and logging on Newfoundland. It is not possible to determine the impact of only linear features because linear features are associated with these developments.

Hunting (IUCN 5.1)

Hunters typically harvest prime-aged individuals (Mahoney and Weir 2009) and the potential for negative impact on population growth is much greater than that of predators, which are more likely to remove old individuals or young of the year (Wright *et al.* 2006). Hunting of the NP is still permitted in most local populations, with the exception of the Avalon Peninsula, Grey River, Burnin Knee, Burnin Foot, and the Blow Me Down Mountains sub-populations (Newfoundland and Labrador Hunting and Trapping Guide 2012). Sport hunting of the NP is closely regulated and the sub-population harvest rates varied from zero to 17.8%, depending on the Caribou status within the management areas (Weir, J. and Luther, G., NLDEC).

Survey effort was relatively limited in the 1990s and managers did not detect that a population decline was underway. Harvest quotas were not lowered soon enough and hunting was found to substantially contribute to the decline of Caribou in late 1990s (Weir, J. and Luther, G., NLDEC; see **Fluctuations and Trends** section). Since 2006, the percent of decline caused by hunting has decreased due to stringent hunting quotas, coupled with a harvest management strategy that is intrinsically tied to population demographics (e.g., size, calf recruitment, adult male component and total harvest) (NLDEC, unpubl. data 2013).

Areas such as Newfoundland with extensive data on harvest rates and population estimates demonstrate that harvesting by humans can have a significant impact on Caribou. Both males and females are hunted, but harvest is male-biased and linked to a skewed sex ratio in some Caribou sub-populations, although males have increased in the NP recently (Weir *et al.* 2014). Annual sales of hunting licences reached an average maximum of about 6,800 licences sold from 1999 to 2003, but have decreased to less than 1000 licences since 2009 because of a lower quota set by the Newfoundland government to stop the decline of Caribou. A decrease in the hunter success rate was observed as the NP declined, with lowest hunter success (60%) observed in 2005. Since 2005, the hunter success rate appears to be increasing, despite the continued decline of the Caribou population.

Logging and Wood Harvesting (IUCN 5.3)

There is evidence of negative impact of forestry on Newfoundland Caribou; fewer females and calves exist near clear-cuts (Chubbs *et al.* 2007) and female Caribou on Newfoundland avoided recent clear-cuts by an average of 9.2km (Schaefer and Mahoney 2007). However, forest harvesting has slowed greatly in recent years in NP range (DNR 2014a) and many Caribou are not dependent upon mature forests, but instead calve and winter in open areas (see **Habitat Requirements** section). Large portions of the land are still relatively undisturbed in the northern boreal regions and on the Avalon Peninsula and southern and central Newfoundland.

Recreational Activities (IUCN 6.1)

In the NP, Caribou were displaced 60-237 m by snowmobile activity, with adult-only groups responding sooner, and travelling farther than groups with calves, and movement was generally less during periods of deeper snow (Mahoney *et al.* 2001). Density of roads and trails is not known but considered to be high in parts of NP range. Access is not limited by roads in open areas, such as the barrens and plateaus.

Forage Limitation (IUCN 7.3)

The amount and quality of food is considered to be a main factor in recent declines (see **Fluctuations and Trends** section). Forage decreased because of high population density of Caribou in the 1990s. Substantial habitat is available and intact, therefore it is unlikely that conditions of decreased forage will persist indefinitely.

Negligible Threats

Fire and Fire Suppression (IUCN 7.1)

In the NP, fire is a rare event and the average amount of land burned annually from 2011-2013 was 632 ha (range 38-1781 ha), which is 0.006% of the island (DNR 2014b). The dynamics of mature forest in western parts of NP range is driven by insect epizootics; the role of climate change on these dynamics is unknown.

Problematic Native Species (IUCN 8.2) – parasites and pathogens

In Newfoundland, the Brainworm, *Elaphostrongylus rangiferi*, was responsible for at least two epizootics of a debilitating neurologic disease, which affects Moose as well as Caribou (Ball *et al.* 2001). *E. rangiferi* was introduced in Newfoundland with Reindeer brought from Norway in 1908 (Lankester and Fong 1998). Caribou appear to be developing Brainworm immunity in NP and outward signs of the disease are less frequently observed. The Brainworm has been recorded in all major sub-populations but in five years (2007-2012) of carcass inspection, few cases were noted and the threat is considered to be minor.

Introduced Genetic Material (IUCN 8.3)

The introduction of Reindeer from Europe in the early 1900s does not appear to have altered genotype of Newfoundland Caribou. Wilkerson (2010) determined that there has been little to no genetic interchange with Norwegian reindeer and island Caribou.

Number of Locations

Newfoundland population

There are an estimated 14 sub-populations on Newfoundland (see **Canadian Range** section) and each varies in their exposure to predation, hunting, poaching, food availability and forestry activities. There is no single threat dominating the population. The number of locations would at least be 14.

Gaspésie population

The GP exists as a small metapopulation of three sub-populations within a small and isolated location (see **Dispersal and Migration** section). There is no single threat that encompasses the three sub-populations. Three locations are recognized because predation and disturbance threats are similar within each sub-population.

Boreal population

The Federal Recovery Strategy (Environment Canada 2012) identified 51 Boreal Caribou ranges from Labrador to the Yukon, and each varies in its exposure to predation, hunting, poaching, food availability and forestry activities. There is no single threat dominating the population. The number of locations would be 'many'.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

All three populations are found only within Canada. The status of the NP was assessed by COSEWIC as Not at Risk in 1984, 2000, and 2002.

In 1984, the GP was listed as Threatened and uplisted in 2000 to Endangered under the *Species at Risk Act* (SARA) due to a sharp decline in recruitment. This status was reconfirmed in 2002 (Table 6). The Québec government also prepared a Recovery Plan for the period 2002-2012 (Comité de rétablissement du caribou de la Gaspésie 2002) and this plan was evaluated for the period 1990-2009 in an interim report published in 2011 (Équipe de rétablissement du caribou de la Gaspésie 2011). GP are listed as Threatened in Québec.

The BP was first assessed in 2000 as Threatened, which was reconfirmed in 2002. Each province within BP range lists Boreal Caribou as a special designation conservation status (*i.e.*, vulnerable, threatened, red-listed), except Saskatchewan and the Yukon, where they are listed as Not at Risk (Table 6). The range of BP is very small in the Yukon and much of the range in Saskatchewan is relatively undisturbed. Boreal Caribou are listed as Vulnerable in Québec. In Ontario, Boreal Caribou in central Ontario ('forest-dwelling woodland caribou') are listed as Threatened, while Boreal Caribou in northern forests (forest-tundra woodland caribou') are not facing similar disturbance threats, and are listed as Not at Risk (OMNR 2012).

Table 6. Federal and provincial current species at risk designations for caribou of three designatable units in Canada.

Designatable Units[1]	Federal status: SARA	Province/Territories	Provincial status	Nature Serve rank[2]
Newfoundland	Not at risk (2002)	Newfoundland & Labrador (island only)	Not at risk	S4
Boreal	Threatened (2002)	NT	Threatened (2012)	S3
		Yukon	Not at risk	S1
		British Columbia (2010)	Red-listed (Threatened-Endangered)	S2
		Alberta	Threatened	S2
		Saskatchewan	Not at risk	SNR
		Manitoba	Endangered (1994)	SNR
		Ontario	Threatened (2007)	S4
		Québec	Vulnerable (2005)	S2S3
		Newfoundland & Labrador (Labrador only)	Threatened (2002)	S2S3
Gaspésie	Endangered (2002)	Québec	Threatened (2009)	N1T1 [3]

[1] As adopted by COSEWIC (2011)

[2] As ranked in 2011 by Nature Serve (2013); S1: critically imperiled, S2: imperiled, S3: vulnerable, S4: apparently secure, SNR: unranked.

[3] As ranked in 2012 by Nature Serve (2013); N1T1: critically imperilled at the national and infrataxon levels.

Non-Legal Status and Ranks

The global status of *Rangifer* is listed by IUCN (2008) as least concern because of their wide circumpolar distribution and large populations, although population declines have been documented for many sub-populations worldwide (Vors and Boyce 2009). However, the taxonomic classification used in this global status is much coarser than what is used in Canada and includes semi-domestic European Reindeer sub-populations as well. Nature Serve (2013) determined the status for the GP as critically imperilled (N1, T1). Nature Serve (2013) also lists the conservation status of Boreal Caribou for each province/territory (Table 6). Caribou are classified as being globally (G5) and nationally (N5) secure in 2006 and 2012 respectively. Wild Species (2010) ranks the Canadian population of Caribou as well as the populations in the NT, Nunavut, Manitoba, Québec, Labrador, and Newfoundland populations as 4 (secure), the Yukon, British Columbia, Saskatchewan, and Ontario populations as 3 (sensitive), and the Alberta population as 1 (at risk).

Habitat Protection and Ownership

Habitat protection is managed by creation of protected areas, but mainly by establishing policy and best-management practices for mitigating the impact of forestry and other resource development on Caribou. Appendix I of the Federal Recovery Strategy outlines generic mitigation practices (Environment Canada 2012). Courtois *et al.* (2008) reported that Caribou would remain in a 2,800 km^2 area where the forest management plan included the preservation of large forest blocks (35-182 km^2) linked with >400 m corridors. It has been noted that the efficacy of these forest range strategies for long-term conservation remain unresolved and may not be apparent for decades because time lags exist between habitat disturbance and extirpation (Vors *et al.* 2007). Most practices are embedded in forest management plans and Caribou conservation plans developed by jurisdictions.

Newfoundland population

Insular Newfoundland has large amounts of undisturbed landscape, most of which is Crown land. A total of 770,000 hectares (11%) in Newfoundland are located within protected areas, which covers 6.7% of the most intensively used areas (core areas) of Caribou on the island, mainly within Gros Morne National Park (Wells *et al.* 2011). Most Caribou Management Areas (CMA) have less than 3% of protection, two CMAs have between 3 and 25% and one CMA has more than 25% of its land protected. There are still sufficient large blocks of undisturbed landscapes to maintain large populations of Caribou on the island; however, there is little habitat protection within these areas (Wells *et al.* 2011).

Caribou are widely distributed island-wide and have seasonal migrations, which make protection of large areas difficult. The Avalon and Bay du Nord Wilderness Reserves were specifically established to be large enough to protect large mobile animals. Nevertheless, these reserves did not insulate the Avalon sub-population from the most recent epizootic of *Elaphostrongylus rangiferi* in 1996-1998 (Ball *et al.* 2001). The Middle Ridge sub-population, which overlaps the Bay du Nord Reserve and Middle Ridge Wildlife Reserve, is the most abundant sub-population on the island.

Much of Newfoundland is unlikely to be developed for commercial forestry because some regions (e.g., southcentral) are largely bog/barren lands and are of little commercial value (NLDEC, unpubl. data 2013). Cranberry and peat farming could occur on bog areas. Parks and reserves are a small part of Caribou conservation on the island because few parks exist where Caribou sub-populations are located. Environmental assessment processes and guidelines exist to reduce impacts of forestry and mining on Caribou (NLDEC, unpubl. data 2013).

Gaspésie population

In 1937, the Québec government established the Gaspésie Park to protect the alpine and sub-alpine landscape of the Mount Albert (1157 m) and other Chic-Chocs mountains like Mount Jacques-Cartier (1270 m) in the vicinity. Caribou habitat was legally defined and protected. In 2006, 657 km^2 was protected, most of which was located within the Gaspésie Park. In 2011, the protected, legally defined habitat was increased to 1,035 km^2, of which 233 km^2 is outside the Gaspésie Park (802 km^2). The remaining legal habitat is found in the Chic-Chocs and Matane Wildlife Reserves and provides a specific protection status for Caribou habitat, including that used by Caribou outside the park that are subject to anthropogenic disturbances like logging, mining and recreational activities (St-Laurent *et al.* 2009).

Since 1997, managers have established silvicultural methods that may preserve Caribou habitat quality outside the Gaspésie Park, while also permitting as much land use and forest exploitation as possible. A first special Forest Management Plan (1999-2004) in the GP range aimed to protect summits with tundra habitats, movement corridors and control deciduous regeneration that is beneficial to Moose and also experiment with partial and irregular logging practices (Champagne *et al.* 1999). The conservation value of some elements of this strategy, like irregular and partial cuts, is not completely known yet (St-Laurent *et al.* 2009). A second Forest Management Plan to help Caribou range conservation outside the park was published in 2007 and was effective until 2012-2013 (Turcotte *et al.* 2007). Most of the areas covered by these two plans were within the legal habitat delineation adopted in 2006. The first two plans were made for a relatively small area of 290 km^2 used by GP outside the park limits while a third plan recently published will cover an area of 2,857 km^2 (Chouinard and Lalonde 2013). The goals of these Forest Management Plans are to: 1) protect tundra summits and their forested high-altitude slopes; 2) maintain arboreal lichen production; 3) limit development of predator habitats; 4) maintain connectivity between Caribou subpopulations; 5) limit disturbance to Caribou; and 6) maintain logging activities for the continuation of forestry. For example, within a 15-km

buffer surrounding the park, clear-cutting is not allowed > 700m asl, and < 700 m, partial cutting is used, and fruit-bearing trees and deciduous stems are reduced as a means of decreasing attractiveness of the area to Moose, White-tailed Deer, and Black Bear (QMRN 2013). The impacts of these Plans on Caribou conservation while simultaneously permitting logging activities remain unknown.

Boreal population

The National Recovery Strategy (Environment Canada 2012) was developed over several years and published in 2012. Conservation and recovery plans have been undertaken in the NT (NT Department of Environment and Natural Resources 2010, NT Species at Risk Committee 2012), in British Columbia (BC Ministry of Environment 2011), in Alberta for the period 2004-2014 (Alberta Woodland Caribou Recovery Team 2005), in Manitoba (MBWCMC 2014), in Ontario (Ontario Woodland Caribou Recovery Team 2008, OMNR 2009, 2012), in Québec for the period 2005-2012 (Équipe de rétablissement du caribou forestier du Québec 2008, 2010) and for the period 2013-2023 (Équipe de rétablissement du caribou forestier du Québec 2013), and in Labrador (Schmelzer *et al.* 2004). Mitigation measures, such as two-pass harvest, road layout to avoid important habitat, and harvesting schedules avoiding critical periods (*i.e.*, calving) are common to forestry plans in areas containing Caribou.

In Labrador, incidental hunting of BP Caribou is minimized in areas that overlap with the hunted but larger George River sub-population (DU4) by delineating 'extension zones' wherein hunting is closed unless large numbers of the migratory George River sub-population are in the area (Schmelzer *et al.* 2004).

The Québec Boreal Caribou 2005 - 2012 Recovery Plan and the more recent 2013-2023 Plan (Équipe de rétablissement du caribou forestier du Québec 2013) are based on a rotation logging method where larger stands (100-250 km^2) were protected until they became quality habitat for Caribou, but also contained commercially harvestable volumes (>75 years). This approach assumes that Caribou will move away from recent cutovers in search of quality habitat elsewhere within their range. Another hypothesis is that Caribou can simply move north and further away from disturbances. The forest harvesting framework in the Québec recovery plan does not consider the proximate factor of avoidance of disturbed habitat, namely predation risk. It remains unknown what predation risks will be present in these future coniferous forests and whether they will comprise suitable habitat for Caribou. As well, there is a potential conflict between Caribou and Moose habitat management in the James Bay region of Québec, where a priority for Moose could impact Caribou (Girard pers. comm. 2014).

Ontario's Boreal Caribou population has been classified as a Threatened species since 2007. Ontario's Woodland Caribou Conservation Plan serves as the provincial government's response to a recovery strategy (OMNR 2009, 2012). The plan's goal is to maintain self-sustaining, genetically connected local populations of Woodland Caribou where they currently exist, improve security and connections among isolated mainland local populations, and facilitate the return of Caribou to strategic areas near their current extent of occurrence. Habitat has been delineated into three categories that reflect seasonal habitat use, function, and risk to disturbance (OMNR 2013a). High Use areas (nursery, winter habitat) typically are used for multiple years, are more sensitive to disturbance, and should receive the highest level of protection. Category 2 areas are Seasonal Range that contain travel corridors, but it is recognized that Caribou effectively space themselves from threats that may change annually, and therefore require areas larger than existing, known annual home ranges (Racey and Arsenault 2007; Avgar *et al.* 2013). High Use areas are typically nested within these Seasonal Ranges, and are dependent on the refuge function provided at this larger spatial scale (OMNR 2013a). Category 3 areas support Caribou indirectly by maintaining the overall refuge function within the range. Category 3 areas are currently young or disturbed (< 40 years old) but are expected to become used habitat in the future as the forest matures and the areas become connected with seasonal range (OMNR 2013a). Critical habitat for BP is defined in the National Recovery Strategy as the area within the boundary of each range that provides an overall ecological condition that will allow for an ongoing recruitment and retirement cycle of habitat, which maintains a perpetual state of a minimum of 65% of the area as undisturbed habitat; and biophysical attributes required by Boreal Caribou to carry out life processes, such as calving, rutting, and winter areas (see Appendix H in Environment Canada 2012). Decisions on resource development relate to how much disturbance each category could withstand but continue to support Caribou (OMNR 2012, 2013b). One category in the conservation plan is based on the expectation of forest harvested areas becoming future Caribou habitat, which is under debate (see **Threats** - Loss or Change in Forest section).

In Manitoba and Saskatchewan, numerous actions, similar to other jurisdictions, are in development and await acceptance of the draft provincial recovery strategy (MBWCMC 2014; Saskatchewan Environment 2014). In Alberta, various restrictions have been developed, including that new exploration and construction activities must apply for permits to minimize impact to calving and other special sites (Alberta Government 2014). The Alberta Woodland Caribou Recovery Plan 2004/05 – 2013/14 proposes actions to preserve Boreal Caribou and classified four categories based on risk of extirpation (Alberta Woodland Caribou Recovery Team 2005). For the highest risk category "Immediate Risk of Extirpation", the Plan proposes a moratorium on further mineral and timber resource allocation be put in place until a land use and range plan is completed, evaluated, and implemented. As of 2013, the plan has not been implemented.

In British Columbia, Boreal Caribou are provincially red-listed (Threatened to Endangered), and are identified as Priority 1 under the BC Conservation Framework. The goals of the BC Implementation Plan for the management of the BP are intended to maximize conservation efforts to benefit Boreal Caribou and support future recovery efforts while providing resource development opportunities (BC Ministry of Environment 2011). Numerous protections have been established in BC, including 13% of the boreal range as Resource Review Areas where a 5-year moratorium exists on new oil and gas leases, 73 sites (Wildlife Habitat Areas, Ungulate Winter Ranges) totalling 977,000 ha where no new roads or harvesting will occur, and > 800,000 ha more where resource activities are altered to mitigate impact to Caribou. An additional 748,000 ha of similar mitigation has been proposed for another part of the range. Additional protected areas comprise 1.4% of the range, and 2% of identified core habitat (BC Ministry of the Environment 2010).

Numerous projects to protect Caribou are underway in various First Nations, and management in most of the remaining BP range involves First Nations. For example, in Ontario, the Lac Seul, Attawapiskat, Cat Lake, Slate Falls, Mishkeegogamang, and Eabametoong First Nations are integrating ATK and scientific data towards identifying critical habitat, stewardship and involvement in land use planning that affects Boreal Caribou (OMNR 2012). In Eeyou Istchee (the southern James Bay region), First Nation communities and government agencies are collaborating on conservation of Caribou, including community-based practices to reduce hunting levels where needed, and to establish protected areas (Saganash 2013; Girard pers. comm. 2014). In Labrador, the Labrador Inuit Association is incorporating components of Inuit 'Customary Law' into resource management policy and to revive traditional concepts of stewardship related to Caribou (Schmelzer *et al.* 2004). The Wek'èezhìi, Sahtu, and Gwich'in Renewable Resource Boards in NT (WRRB 2013; SRRB 2010), and the Cree in southern James Bay region (CRA 2010) are very active in ATK gathering and publications on BP Caribou.

Relatively few protected areas exist in the boreal forest and the majority of these are not large or specific enough to accommodate the space needs of Boreal Caribou. Proposals exist for the creation of large parks or reserves in some provinces or territories with areas >10,000 km^2, as Environment Canada (2012) reported that 300 Caribou are needed for a self-sustaining local population, thereby requiring ranges of at least 10,000 to 15,000 km^2 of habitat to meet their space requirements. Parks Canada and Newfoundland and Labrador's Department of Environment and Conservation announced the imminent establishment of a new national park reserve in the Mealy Mountain (Akamiuapishkua) area of Labrador. The park reserve will protect roughly 10,700 km^2, which will make it the largest national park in eastern Canada. The provincial government also announced its intent to establish a waterway provincial park to protect the Eagle River, adjacent to the proposed national park reserve. Together these areas would protect 13,668 km^2 in Boreal Caribou range, primarily of the Mealy Mountain sub-population.

In Québec, protected areas that facilitate exchanges and connectivity between local sub-populations have been proposed as an essential tool to maintain Caribou (Rudolph *et al.* 2012). The area traditionally used by the Charlevoix Caribou sub-population covers approximately 5,500 km^2 and overlaps the Laurentides Wildlife Reserve and three parks, but it is the most heavily disturbed (80-99%) Caribou range in Québec (Environment Canada 2011; St-Laurent pers. comm. 2014). Extensive forestry activities in the Laurentides Wildlife Reserve and on Crown land may threaten the sub-population's persistence (St-Laurent and Dussault 2012). The process of creating the biodiversity reserve project of Albanel-Témiscamie-Otish is ongoing in Québec (11,871 km^2) (Équipe de rétablissement du caribou forestier du Québec 2010), but a small proportion will offer protection to Caribou (Girard pers. comm. 2014). A future park (3200 km^2) in Assinica region would offer protection to portions of Caribou range in the area (Girard pers. comm. 2014).

In Ontario and Manitoba, several protected areas are found within the continuous BP range, and a World Heritage site has been proposed (Brannen pers. comm. 2014). However, even the largest of these parks, such as Wabakimi (8,920 km^2), Atikaki (3,980 km^2), and Woodland Caribou Provincial Parks (4,500 km^2) may not be large enough to effectively conserve more than a few sub-populations (MBWCMC 2014). Elsewhere, smaller protected areas will be impacted by habitat change associated with the northward advancing front of forest harvest (Vors *et al.* 2007).

The creation of five large national wildlife areas in the NT is currently being studied by the Canadian Wildlife Service (Bigelow pers. comm.). The Dehcho First Nations interim land withdrawal agreement and the Wood Buffalo National Park would protect 32,633 km^2, the largest in BP range in Canada. Another protected area project will have a total contiguous area of 14,688 km^2. It should be noted, however, that these proposed protection areas may have some levels of anthropogenic and natural (fire) disturbance already present.

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Serge Couturier received his BSc in Biology at Université du Québec à Rimouski, and his MSc and PhD in Biology at Université Laval. His PhD dissertation focused on the ecology of Caribou from three ecotypes. In 1985, he joined the Québec government, first in the Northern Québec Regional office, and later in the Wildlife Research Department with an emphasis on monitoring of Caribou populations. Since 2012, he has worked as a consultant on projects dealing with Caribou. Serge is an Associate Professor at Université Laval and has co-authored many scientific papers and reports focusing on Caribou.

Liv S. Vors received her BSc from the University of Saskatchewan, and MSc at Trent University on the relationship between anthropogenic landscape change and Boreal Caribou habitat occupancy in Ontario. She received a PhD from the University of Alberta in 2013 studying the population ecology of migratory and Boreal Caribou. She has additionally worked as an independent consultant on Caribou for Environment Canada, the Environmental Commissioner of Ontario, Yukon College, and other institutions.

Issac Hébert received his B. Agri and Env. Sc. at McGill University and MSc at Concordia University on the spatial structure and habitat selection of Newfoundland Caribou.

COLLECTIONS EXAMINED

No collection was examined during the preparation of this status report.

Appendix 1. Threats calculator for Caribou – Boreal population

Species	Caribou - Boreal population
Date	08/09/2014
Assessor(s):	Members: Dave F. (moderator), Graham Forbes (TM SSC Co-chair), Donna Hurlburt (ATK SC Co-chair), Suzanne Carrière (NT), Nic Larter (NT), Isabelle Gauthier (QC), Thomas Jung (YK), Ruben Boles (CWS) External Experts: Martin-Hughes St-Laurent (TM SSC Member), Dave Hervieux (AB), Dale Seip (BC), Dennis Brannen (MB), Maria Arlt (MB), Joanna Wilson (NT), Lisa Worthington (NT), Darren Elder (ON), Tim Trottier (SK), Stephen Virc (CWS), Melissa Vance (CWS), Greg Wilson (CWS), Rich Russell (CWS), Sylvain Giguère (CWS), Isabelle Thibault (QC), Julien Mainguy (QC), Melinda Lalonde (QC), Claude Dussault (QC)

Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	1	0
C	Medium	3	2
D	Low	1	3
Calculated Overall Threat Impact:		Very High	High

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	
1.1	Housing & urban areas		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	A small portion of the range would be affected (nationally), but if affected, impact is severe (71-100%) - Caribou do not exist in housing/urban areas.
1.2	Commercial & industrial areas		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	Scope: Neglible * AB (industrial camps): all herds, except mountain Caribou, will be affected. Scope is above neglible for AB and northeastern BC * NT: there is residential area associated with this threat, but to be included along with residential areas associated with 3.1
1.3	Tourism & recreation areas		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	ON: increase not expected over next 10 years (albeit, noise disturbance may be an issue); sites are dispersed and widespread in the northern region
2	Agriculture & aquaculture		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	
2.2	Wood & pulp plantations						Not an issue (tree farm; not forestry)
2.3	Livestock farming & ranching		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	AB: Major issue in some areas; few 100 kms of agricultural land in Caribou range recently made available in NE Alberta BC: not much incremental stuff happening
3	Energy production & mining	CD	Medium - Low	Large - Restricted (11-70%)	Moderate - Slight (1-30%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3.1	Oil & gas drilling	CD	Medium - Low	Large - Restricted (11-70%)	Moderate - Slight (1-30%)	High (Continuing)	Scope * AB: in western sedimentary region (AB, BC, SK - south of shield, MB, YK, NT) would be pervasive (71-100%). It won't take much to affect the Caribou negatively because oil/gas already significant in AB, BC, SK, and MB Severity: range varies given the variation of the threat across the range * AB: believes it'll be more than slight because alienation due to oil/gas; Caribou generally do not exist near piplines and gaslines.
3.2	Mining & quarrying	D	Low	Small (1-10%)	Extreme (71-100%)	High (Continuing)	Scope: Canada is at the borderline of small and negligible (some jurisdictions are higher than 1%) * ON: barely negligible now, but in the next 10 years, this threat will grow. ON has committed infrastructure support, and footprint will be significant. * QC: 1-10% due to mining * NT: nothing * SK: small, boreal shields have quite a few mines already * AB: is greater than 1% because this takes into account oil sands, which they did not include in 3.1
4	Transportation & service corridors	C	Medium	Large (31-70%)	Moderate (11-30%)	High (Continuing)	ROLL UP: all in agreement to increase the Scope to LARGE
4.1	Roads & railroads	CD	Medium - Low	Large - Restricted (11-70%)	Moderate (11-30%)	High (Continuing)	Scope * AB and BC: pervasive * MB: seeing more new roads on the east side * NT: negligible up north * QC: large (31-70%) but on the low end of the scope * SK: has lots of roads and expecting more, which will affect a third of the boreal range Severity * would be higher than 3.1 because of displacement associated with roads * displacement increases predation pressures
4.2	Utility & service lines	D	Low	Restricted - Small (1-30%)	Moderate - Slight (1-30%)	High (Continuing)	Scope: Range is given for Canada, but not near 1% * NT: small (similar to mining) * footprint is small but affects a large percentage of Caribou * QC: small (1-10%) * most in agreement that scope will not be greater than 30%

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5	Biological resource use	CD	Medium - Low	Large - Restricted (11-70%)	Moderate - Slight (1-30%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals	CD	Medium - Low	Large - Restricted (11-70%)	Moderate - Slight (1-30%)	High (Continuing)	* AB, MB, and SK: restricted (11-30%) * ON: unknown but the potential is there * QC: there is harvesting pressure from First Nations, which were associated with some recent declines * there are issues of hunting on the 3 Labrador herds * 100% are at risk but dependent on population size. Bigger herds can sustain harvest
5.2	Gathering terrestrial plants	D	Low	Small (1-10%)	Extreme (71-100%)	High (Continuing)	Includes Peat Moss Harvesting - which is a rapidly increasing industry * AB: applications standing for more than 10% * SK: growing as well within the last year Note: lost habitat takes a long time to regenerate before it can be Caribou habitat again
5.3	Logging & wood harvesting	B	High	Large (31-70%)	Extreme (71-100%)	High (Continuing)	Scope: Large (closer to 30% than 70%) * AB and SK: pervasive (71-100%), but in the absence of predation, comfortable with large. In the west, 40% of the range is affected by logging * NT: 100% * QC: large (31-70%) * ON: the southern range of ON, about half of that range has seen 10% change in forestry activity Note: threat would be higher if we use a longer time frame. Severity: Extreme * logging impact seen as more significant than oil/gas because Caribou can live in the oil fields (albeit, mortality is higher), but Caribou do not use recent harvest areas.
6	Human intrusions & disturbance		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
6.1	Recreational activities		Unknown	Large (31-70%)	Unknown	High (Continuing)	* AB: there are some recreational activities (ex. snowmobile network) that facilitate Wolf travel * NT: lower up north, about 20% of its range affected * MB and SK: also have recreational activities (ex. snowmobiles) that would provide access to Caribou habitat. Severity: Unknown * difficult to attribute population decline

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.2	War, civil unrest & military exercises		Negligible	Negligible (<1%)	Unknown	High (Continuing)	* AB: Cold Lake Weapons range - no calves are surviving, which may be related to low level flying * impacts for Labrador appear to be minor
6.3	Work & other activities		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Threat is everywhere across Canada (i.e. surveyors, exploration flights, etc.)
7	Natural system modifications	D	Low	Restricted - Small(1-30%)	Moderate - Slight (1-30%)	High (Continuing)	
7.1	Fire & fire suppression	D	Low	Restricted - Small (1-30%)	Moderate - Slight (1-30%)	High (Continuing)	Scope: * NT: very bad (about 71-100%) but most of the fires this year affected the Barren-ground Caribou and not Boreal Caribou * BC: closer to 30-40% for the percentage of the range that is affected by burns * ON: 30-50% Severity * 1% of the landscape burns every year; if more fires than normal, it'll be 11-30%
7.2	Dams & water management/ use		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	* BC: zero * ON: new proposals exist but unlikely to begin in the next 10 years * SK: also has a few proposals; but wondering about water management around peatmoss harvesting * One herd in Labrador affected by cumulative impacts, including dam
8	Invasive & other problematic species & genes	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	
8.1	Invasive non-native/alien species		Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs)	Note: Caribou typically extirpated in areas with brainworm.
8.2	Problematic native species	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	* AB and BC: 100% * AB: all boreal Caribou on boreal plains (south of shield) will be gone if mortality rates from predators continue * NT: if we include predation from roads/oil/gas/logging, pervasive looks good; it's at least 70%. Severity: range was decided, but closer to 30-40%.* there are estimate declines available for the last 10 years, but numbers are very crude and no confidence. Everyone is reporting a decline except NT and parts of SK. About a third of the population is in decline but we don't have earlier population data to compare.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.3	Introduced genetic material						Not an issue (but this is a threat for DU5 - Newfoundland population)
9	Pollution		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Noise pollution was included in other threats Possible issue with fracking (intensive nature of its footprint)
9.2	Industrial & military effluents		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Caribou licking pipeline leaks
11	Climate change & severe weather		Unknown	Small (1-10%)	Unknown	High (Continuing)	
11.1	Habitat shifting & alteration		Unknown	Small (1-10%)	Unknown	High (Continuing)	NEEDS FURTHER REVIEW * NT: this will change habitat faster than human factors. There is a small scale study showing that forests are turning into bogs, but unsure how widespread this is with other northern populations. 10% of the habitat has disappeared in the last 10 years. The rate of permafrost loss is 1-5%/year * AB: climate change is a factor but can't see this within the next 10 years. Reference: Forests on thawing permafrost: fragmentation, edge effects, and net forest loss (Baltzer *et al.* 2013)
11.3	Temperature extremes		Not Calculated (outside assessment timeframe)	Pervasive (71-100%)	Unknown	Low (Possibly in the long term, >10 yrs)	* QC: this will be a problem in the future Note: there is not enough information to determine the severity

Appendix 2. Threats calculator for Caribou – Atlantic-Gaspésie population

Species	Caribou – Atlantic-Gaspésie population
Date:	08/09/2014
Assessor(s):	Dave Fraser (moderator), Graham Forbes (TM SSC Co-chair), Isabelle Gauthier (QC), Martin St-Laurent (TM SSC member) QC: Isabelle Thibault, Julien Mainguy, Melinda Lalonde, Claude Dussault

Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	
Threat Impact		**high range**	**low range**
A	Very High	3	3
B	High	2	2
C	Medium	0	0
D	Low	2	2
Calculated Overall Threat Impact:		Very High	Very High

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development	B	High	Pervasive (71-100%)	Serious (31-70%)	High (Continuing)	
1.2	Commercial & industrial areas	D	Low	Small (1-10%)	Serious (31-70%)	Moderate (Possibly in the short term, < 10 yrs)	Natural water pumping station is planned and authorization underway; its location will be adjacent to largest herd.
1.3	Tourism & recreation areas	B	High	Pervasive (71-100%)	Serious (31-70%)	High (Continuing)	Ecolodge already exists within Gaspésie Park, with potential for new development around the national park within the next 10 years. New infrastructure will be within core Caribou habitat.
3	Energy production & mining	A	Very High	Pervasive (71-100%)	Extreme (71-100%)	High (Continuing)	
3.1	Oil & gas drilling						Not an issue (at present)
3.2	Mining & quarrying	C	Medium	Large (31-70%)	Moderate (11-30%)	Moderate (Possibly in the short term, < 10 yrs)	There is demand for exploitation annually but no indication that a new mine will be built soon. The potential threat and score is based on past results wherein Caribou quickly abandoned area near new mines built in the 1950s.
3.3	Renewable energy	A	Very High	Pervasive (71-100%)	Extreme (71-100%)	High (Continuing)	There are already a couple of windmills in the area and 3 new projects are under review/analysis. The projected plans place windmills close to the Caribou range. A wind farm is expected within the next 5 years, resulting in impact to > half of the population due to forest/habitat loss.
4	Transportation & service corridors	B	High	Large (31-70%)	Serious (31-70%)	High (Continuing)	Overall rollup for Threat 4 was bumped up to LARGE

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.1	Roads & railroads	B	High	Large (31-70%)	Serious (31-70%)	High (Continuing)	Approximately 75% cumulative disturbance levels at present, based on methods in Environment Canada (2012).
4.2	Utility & service lines	D	Low	Small (1-10%)	Moderate (11-30%)	High (Continuing)	Been done and still continuing.
4.4	Flight paths						Regular, scheduled aircraft flights are not an issue. Refer to 6.3 for threats due to Ministry's flight path.
5	Biological resource use	A	Very High	Pervasive (71-100%)	Extreme (71-100%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals	D	Low	Restricted (11-30%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs)	This one is tricky, because poaching has and does occur in the wildlife reserve. It wouldn't take much of an increase in poaching to cause a problem.
5.3	Logging & wood harvesting	A	Very High	Pervasive (71-100%)	Extreme (71-100%)	High (Continuing)	Up to 1970, there was still logging in and around the park, which has proved to be problematic. Habitat is still not suitable for Caribou from those early logging practices. Furthermore, the park is still not large enough to protect the Caribou. Note: predation was not included in this calculation
6	Human intrusions & disturbance	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
6.1	Recreational activities	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Recreation (ex. hiking, snowmobile, biking) occurs in and around Gaspésie Park, which is a threat because this causes Caribou to leave areas of higher predation risk.
6.2	War, civil unrest & military exercises		Negligible	Small (1-10%)	Negligible (<1%)	-- Uncertainty Ranges --	There is uncertainty if military training is occurring, but if it does happen, falls within Caribou habitat.
6.3	Work & other activities	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Helicopters used for annual surveys but not all of area impacted. Impact to population not expected. Severity: at most is 1-10%.
7	Natural system modifications		Unknown	Unknown	Unknown	High (Continuing)	
7.1	Fire & fire suppression		Unknown	Unknown	Unknown	Unknown	No studies have been done
8	Invasive & other problematic species & genes	A	Very High	Pervasive (71-100%)	Extreme (71-100%)	High (Continuing)	
8.1	Invasive non-native/alien species		Unknown	Unknown	Unknown	Unknown	Currently there is no information on pathogens but surveys for *Neospora* and other diseases underway.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.2	Problematic native species	A	Very High	Pervasive (71-100%)	Extreme (71-100%)	High (Continuing)	Bears and coyotes are problematic.
9	Pollution		Unknown	Unknown	Moderate - Slight (1-30%)	Moderate (Possibly in the short term, < 10 yrs)	
9.2	Industrial & military effluents		Unknown	Unknown	Moderate - Slight (1-30%)	Moderate (Possibly in the short term, < 10 yrs)	Proposed water pumping station will generate pollutants but information is lacking to evaluate the potential threat; a range is given for severity.
9.4	Garbage & solid waste						Increase in hunter waste leads to possibility of predation, but not a proximate factor. Recently, waste bins within the parks have been found filled with hunting waste (ex. head, skin, legs).
10	Geological events	D	Low	Small (1-10%)	Serious (31-70%)	Moderate (Possibly in the short term, < 10 yrs)	
10.3	Avalanches/landslides	D	Low	Small (1-10%)	Serious - Moderate (11-70%)	Moderate (Possibly in the short term, < 10 yrs)	Caribou are lost to avalanches ~ every 2 years and a significant % of a small population could be killed in one event. Scope: only certain mountains are prone to avalanches
11	Climate change & severe weather		Unknown	Large (31-70%)	Unknown	Moderate (Possibly in the short term, < 10 yrs)	
11.1	Habitat shifting & alteration		Not Calculated (outside assessment timeframe)	Pervasive (71-100%)	Unknown	Low (Possibly in the long term, >10 yrs)	
11.3	Temperature extremes		Unknown	Large (31-70%)	Unknown	Moderate (Possibly in the short term, < 10 yrs)	Mostly due to ice storms that are more and more frequent.

Appendix 3. Threats calculator for Caribou – Newfoundland population

Species	Caribou - Newfoundland population
Date:	29/07/2014
Assessor(s):	Dave F. (moderator), Graham Forbes (TM SSC Co-chair), Shelley Pardy Moores (NL), Donna Hurlburt (ATK SC Co-chair), Ruben Boles (CWS) NL: Isabelle Schmelzer, Kirsten Miller, Rob Otto, Keith Lewis CWS: Krista Baker

Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	0	0
C	Medium	1	0
D	Low	3	4
Calculated Overall Threat Impact:		High	Medium

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development		Unknown	Small (1-10%)	Unknown	Unknown	
1.1	Housing & urban areas		Unknown	Small (1-10%)	Unknown	Unknown	Scope: based on cabin/cottages and new development in the next 10 years - believed to be small; 30% is too high for the scope. Severity: the amount of population impacted from cottages being built - actual development less concern than hunting/road access/human intrusion, etc.), which will be covered in Threats 5 and 6 below - based on number of cottages and Crown land, this would be small based on the area of the land - with no actual evidence or comfort from the experts, consensus was UNKNOWN
1.2	Commercial & industrial areas		Unknown	Unknown	Unknown	Unknown	UNKNOWN; NL does not have anything proposed in the next 10 years
1.3	Tourism & recreation areas		Unknown	Unknown	Unknown	Unknown	UNKNOWN; NL does not have anything proposed in the next 10 years
2	Agriculture & aquaculture		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
2.1	Annual & perennial non-timber crops		Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)	There is small amount of cranberry farming in past but nothing presently Scope: even if new cranberry farming is proposed, it'll be < 1% Severity: experts are unsure: could be Negligible or Neutral/Potential Benefit
2.2	Wood & pulp plantations						Experts decided to leave BLANK - doesn't seem to fit and would be small for planted pine

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.3	Livestock farming & ranching		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	There are no new proposals, but if determining the threat from the current farming/ranching, threat would be negligible.
3	Energy production & mining	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	
3.1	Oil & gas drilling		Negligible	Negligible (<1%)	Negligible (<1%)	Low (Possibly, >10 yrs)	Possibly 'small' in the next 10 years; there is a current moratorium on fracking. It will be small, but definitely emerging; there will be some habitat loss, but probably minimal.
3.2	Mining & quarrying	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	This industry is rapidly growing in NL Severity: evidence that the Caribou avoid area of mining, and therefore population decline, is minimal. There could be habitat loss but population may not be affected - there is a lot of uncertainty but it's at the low end of 1-10% - a lot of the mining/quarrying activity is in the exploration stage and we don't have the information on what the impacts would be. Reference: Weir *et al.* (2007)
3.3	Renewable energy	D	Low	Small (1-10%)	Moderate (11-30%)	High (Continuing)	Scope: there is impact on movement but on the low end of 1-10% - there is small impact on a small % of the population
4	Transportation & service corridors		Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)	
4.1	Roads & railroads		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Scope: focus here is on roadkill; at least 31-70% of the sub-populations are affected by the roads; there are lots of logging roads and highways in NL, but the threat may be slight or negligible, based on just roadkill. Severity: experts don't believe that more than 300 Caribou would be hit by a car/year based on 30000+ Caribou on NL

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.2	Utility & service lines		Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)	Scope: dealing with just the actual utility and not the spillover effect - a new 700 km² line is coming in so this threat will increase; part of that line is borrowing from existing infrastructure. Construction is over a large part of the peninsula and continues to the centre of the island. It's a large area, but not all area will have Caribou associated with it - numerous transmission lines in Caribou existing habitat - the new line added to Labrador was over 6 times as wide but we are uncertain about the width of the new line for NL. Severity: severity to be determined - don't anticipate that Caribou will be killed at the construction; they will most likely avoid the area; mitigation in effect to avoid blasting when Caribou are present; once the line is built, it doesn't seem to bother the Caribou. The main issue is the planning (line location) and construction.
5	Biological resource use	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Scope: the extent of the population under harvest pressure (legal and illegal)! - Shelley: a majority of the range isn't opened for hunting. We might need to go with the number of permits (740 licences/year). - we need to look at the % of the hunting (exclude area where hunting is not allowed & poaching does not exist). Hunting is most likely pervasive Severity: fairly minor decline. there is a population model that shows decline from hunting and decline with no hunting - we will need to revisit the numbers in the model to get a better understanding of the range
5.3	Logging & wood harvesting	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	Scope: what % of caribou would experience logging pressure or logging system? the range is equally divided between forested and non-forested areas. Severity: what would be the 3 generation decline in the last 10 years? - behavioural response is avoidance of the area; they avoid the cutting, may return for new growth - present impact is slight; NL did have the 2-3 major pulp mills but they have been closed or reduced in capacity. References: Chubbs *et al.* (2007); Schaefer and Mahoney (2007); Hebert (2012)

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6	Human intrusions & disturbance	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
6.1	Recreational activities	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Scope: What % of these Caribou experience human activities (ex. ATV, skidoo, snowmobiles); believe activity is definitely 'high'. Gros Morne gets very high snowmobile activities - energetic impact: some people chase and drive the machines towards Caribou but this is probably negligible in terms of population impact. Reference: Mahoney *et al.* (2001)
6.2	War, civil unrest & military exercises		Unknown	Unknown	Unknown	Unknown	Not applicable or UNKNOWN - Shelley: military exercises may occur on the island; they get 1-2 calls/year from military regarding training exercises
6.3	Work & other activities		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	Research would fall into this category (radio-collaring work) There is some painting (marking individuals) planned (in any one year, there could be 20-30 painting) but don't know if there is mortality associated with it. Even if there are 1-2 deaths, that won't affect the overall decline
7	Natural system modifications		Negligible	Negligible (<1%)	Unknown	High (Continuing)	
7.1	Fire & fire suppression		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Scope: there are fires every year on the island, but usually very low - the number of Caribou affected is small, possibly just on the Avalon peninsula and the portion of Caribou on the peninsula affected would be negligible
7.2	Dams & water management/use						Not applicable - there are no new proposals
7.3	Other ecosystem modifications						Not applicable: conversion for Moose browsing believed to not cause an impact on Caribou
8	Invasive & other problematic species & genes	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	
8.1	Invasive non-native/alien species	D	Low	Pervasive - Large (31-100%)	Slight (1-10%)	High (Continuing)	Brainworm: introduced by Reindeer from Norway - we don't know the infection rate, but most Caribou appear to develop an immunity since the 1990s; scope of 31-100% to cover some of the uncertainty
8.2	Problematic native species	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	increase in Moose numbers will benefit the Coyote Severity: rank as 1-30% but we will revisit the data and update the group

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.3	Introduced genetic material						Little to no genetic interchange between Newfoundland Caribou and Norwegian Reindeer when Reindeer were introduced to Newfoundland in the early 1900s. Reference: Wilkerson (2010).
11	Climate change & severe weather		Unknown	Large (31-70%)	Unknown	Unknown	Climate change is something to consider, but there is no data showing how Caribou are reacting. Plant phenology may impact calving and feeding, but unknown. Freezing events noted in southern part of the range.
11.1	Habitat shifting & alteration		Unknown	Large (31-70%)	Unknown	Unknown	Could be an issue
11.3	Storms & flooding		Unknown	Unknown	Unknown	Unknown	Could be an issue